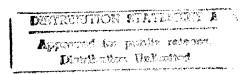
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## China Report

SCIENCE AND TECHNOLOGY



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# CHINA REPORT Science and Technology

## CONTENTS

## PEOPLE'S REPUBLIC OF CHINA

NATIONAL DEVELOPMENTS	
Liu Zheng on Importance of Science, Technology (Hunan Provincial Service, 4 Jan 84)	1
Provincial Science, Technology Group Established (Human Provincial Service, 19 Dec 83)	3
APPLIED SCIENCES	
Magnetohydrodynamic Flow of Two-Component Gas Analyzed (Rong Sheng; LIXUE XUEBAO, No 3, 1983)	4
Development of Robot Technology in Shanghai Surveyed (Lu Xueshi, Xu Huichang; ZUHE JICHUANG, No 5, 1983)	11
New Telecommunications Optical Fiber Developed (XINHUA, 13 Jan 84)	24
LIFE SCIENCES	
Major Medical Science Achievements Made (XINHUA, 10 Jan 84)	26
Briefs Shanghai Advanced Medical Analyzer	27
PUBLICATIONS	
Annual Index to Laser Journal Published (ZHONGGUO JIGUANG, No 12, 20 Dec 83)	28

### ABS TRACTS

ARMAMEN 15	
BINGGONG XUEBAO [ACTA ARMAMENTARII], No 4, Nov 83	35
CDMA SYSTEMS	
TONGXIN XUEBAO [JOURNAL OF CHINA INSTITUTE OF COMMUNICA- TIONS], No 4, 1983	37
CHARACTER RECOGNITION	
TONGXIN XUEBAO [JOURNAL OF CHINA INSTITUTE OF COMMUNICA-TIONS], No 4, 1983)	38
CHEMISTRY	
HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEER-ING (CHINA)], No 3,,Sep 83	39
CONTRACEPTIVES STUDIES	
YAOXUE XUEBAO [ACTA PHARMACEUTICA SINICA], No 10, 29 Oct 83	41
NUCLEAR PHYSICS	
YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS], No 3, Aug 83	42
PETROLEUM, URANIUM GEOLOGY	
YANSHI KUANGWU JI CESHI [ACTA PETROLOGICA MINERALOGICA ET ANALYTICA], No 3, Sep 83	44

#### NATIONAL DEVELOPMENTS

#### LIU ZHENG ON IMPORTANCE OF SCIENCE, TECHNOLOGY

HK050713 Changsha Hunan Provincial Service in Mandarin 2310 GMT 4 Jan 84

[Text] At the provincial conference on exchanging experience in science and technical association work which started yesterday, Liu Zheng, secretary of the provincial CPC committee and governor, said: If we do not attach great importance to scientific and technical progress, the goal of invigorating Hunan's economy will become hopeless. He said: We must have a feeling of urgency regarding this issue. Comrade Liu Zheng said: The achievements in industrial and agricultural production made by the province in the 30-odd years since liberation, particularly since the 3d Plenary Session of the 11th CPC Central Committee, should be fully affirmed. However, we should realize sober-mindedly that economic development is extremely rapid at home and abroad, and that we are facing the challenge of a world industrial revolution. We should frankly admit that our province's economy is still rather backward. In order to put an end to this situation, we must rely on scientific and technical progress.

Comrade Liu Zheng stressed: Science and technology must be geared to the needs of economic construction, and must serve the invigoration of the economy. They must be geared first to the needs of Hunan's economic construction, and we must make the most of the power of science and technology in invigorating Hunan's economy. We must by no means seek things far and wide while neglecting what lies close at hand, or seek illusion while neglecting reality.

Comrade Liu Zheng said: We must spend much effort in reforming scientific and technical work. We have to reform the scientific research system and change the style of thinking in accordance with the actual conditions in Hunan, so as to open up new vistas through the practice of reform.

In his speech, Comrade Liu Zheng urged that the scientific and technical association be truly run as a home of scientific and technical workers, and that all scientific and technical workers throughout the province be mobilized and organized better to serve the invigoration of the economy.

All societies, associations, and research institutes directly under the provincial authorities, as well as responsible persons of all prefectural,

city, autonomous prefectural, and county scientific associations; and representatives of the advanced collectives and advanced individuals which are directly under them, totaling more than 300 people, attended this conference.

Yin Changmin, Standing Committee member of the provincial CPC committee, and Yang Difu, vice chairman of the provincial CPPCC committee, were present at yesterday's conference.

The Chinese Scientific and Technical Association, as well as provincial and regional scientific and technical associations, such as Hubei, Guangxi, and Sichuan, have sent congratulatory telegrams. Representatives of the Guangdong Scientific and Technical Association joined in the conference by invitation, and delivered a speech of congratulation at the conference yesterday.

CSO: 4008/105

#### NATIONAL DEVELOPMENTS

PROVINCIAL SCIENCE, TECHNOLOGY GROUP ESTABLISHED

HK201431 Changsha Hunan Provincial Service in Mandarin 2310 GMT 19 Dec 83

[Text] According to HUNAN RIBAO, the science and technology leading group of the provincial people's government was recently set up. Liu Zheng, provincial CPC committee secretary and governor, was appointed the head of the group and (Yin Changming), (Shi Jie), (Chi Yungui), (He Xiangchu), (Huang Peiyun), and other comrades were appointed deputy heads of the group. The responsible comrades of the provincial Planning Commission, Economic Commission, National Defense Science and Industry Office, Urban and Rural Construction and Environmental Protection Department, Labor and Personnel Department, Education Department, Financial Department, Science and Technology Commission, and Association for Science and Technology are all members of the group.

The science and technology leading group is responsible for implementing the party and state's principles and policies on the development of science and technology, exercising unified command over and coordinating the scientific and technological work throughout the province, examining and approving the province's plans for scientific and technological research and for the application and popularization of science and technology, including the plans for technical transformation in all the trades and key enterprises in the province, examining and approving the schemes for tackling and thoroughly resolving major scientific and technological hurdles, studying the decision concerning major policies related to technology, and examining and deciding matters related to major projects for introducing and assimulating foreign technology.

CSO: 4008/105

#### APPLIED SCIENCES

## MAGNETOHYDRODYNAMIC FLOW OF TWO-COMPONENT GAS ANALYZED

Beijing LIXUE XUEBAO [ACTA MECHANICA SINICA] in Chinese No 3, 1983 pp 293-297

[Article by Rong Sheng [2837 7105], Institute of Mechanics, CAS: "Magneto-hydrodynamic Flow of a Two-Component Gas and Its Applications"]

[Text] Because of the steadily increasing need for isotope separation, increasing the homopolar separation coefficient and yield has become an extremely important problem. Mechanical centrifuges achieve separation by high-speed rotation of two different gases or liquids. But because of structural strength limitations and equipment vibration it is difficult to continue increasing their separation effectiveness. Is it possible to use electromagnetic fields to bring two gaseous isotopes to higher rotary speeds so as to achieve separation? The feasibility of this approach was first investigated in the 1960's. Gross et al. used an electromagnetic force to accelerate an ionized gas, achieving rotary speeds of 108 cm/sec in the laboratory. The technical difficulty in electromagnetic centrifuge separation of isotopes involves the gas ionization are relatively promising methods. The present paper gives a theoretical analysis of the flow of a two-component gas under the influence of radial and magnetic fields, derives the rotation speed, temperature and density ratio distribution, shows theoretically that the use of electromagnetic centrifugation for isotope separation can achieve relatively high rotary speeds and rather large separation characteristics and yields, and indicates the limitations on rotary speed.

Fig. 1 is a diagram of the flow of a two-component gas. The inner and outer electrodes consist of coaxial cylindrical surfaces in which there are many small holes; the gas is injected tangentially through the outer electrode and flows out through the electrodes after acceleration by the electromagnetic field.

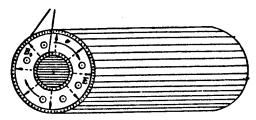


Figure 1. Flow Diagram

#### 1. Basic Assumptions

- A. The flow is constant and axially symmetrical, and the physical characteristics of the flow field are functions only of the radial coordinate  $r^*$ .
- B. For a small magnetic Reynolds number, the electric and magnetic field intensities are  $\bar{E}=(E_0r^*/r_0^*,\ 0,\ 0)$ ,  $\bar{B}=(0,\ 0,\ B_0)$ , in cylindrical coordinates  $r^*$ ,  $\theta^*$  and  $z^*$ .  $E_0$  and  $B_0$  are constants, and  $r_1^*$  and  $r_0^*$  are the radii of the inner and outer electrodes respectively.
- C. We neglect the viscosity of the gas, heat conduction effects, and chemical reactions.
- ${\tt D.}$  The constant-volume and constant-pressure specific heats of the gases are constant.
- E. The gas consists of two components of different atomic weights.

The equations defining the density, concentration, pressure, velocity vector, enthalpy, specific heat at constant pressure, specific heat at constant volume, radial flow rate and temperature of the gas are:

$$\rho^* = \rho_1^* + \rho_2^*, \quad n = n_1 + n_2, \quad p^* = p_1^* + p_2^*$$

$$\bar{v}^* = \frac{\rho_1^* \bar{v}_1^* + \rho_2^* v_2^*}{\rho^*}, \quad h^* = \frac{h_1^* \rho_1^* + h_2^* \rho_2}{\rho^*},$$

$$c_\rho = \frac{c_{\rho_1} G_1 + c_{\rho_2} G_2}{G}, \quad c_r = \frac{c_{\nu_1} G_1 + c_{\nu_2} G_2}{G},$$

$$G = \rho^* u^* r^*, \qquad T^* = \frac{h^*}{c_\rho}$$

Subscripts 1 and 2 indicate the light and heavy components respectively. The diffusion speeds of the components are  $\bar{w}^* = \bar{v}_1^* - \bar{v}$  (i = 1, 2), and their radial components are  $u_1^*$ . The density ratio of the heavy component to the light component is  $y = n_1/n_2$ . Considering the two-dimensional case,  $\bar{v}^* = (u^*, v^*, \theta)$ .

2. Basic Equations, Solution Conditions and Solution

We introduce the following dimensionless variables and coefficients:

$$\rho = \rho^*/\rho_0^*, \quad p = p^*/\rho_0^* v_0^{*2} \quad v = v^*/v_0^*, \quad u = u^*/u_0^*$$

$$T = T^*/T_0^*, \quad r = r^*/r_0^*, \quad \varepsilon = u_0^*/v_0^*, \quad v_c = E_0/B_0 v_0^*$$

$$\delta = \frac{\sigma r_0^{*2} B_0^2}{\rho_0^* u_0^*}, \quad M_0^2 = \frac{v_0^{*2}}{\Gamma \rho_0^*/\rho_0^*}, \quad D = \frac{3m_1}{8\sigma_{12}^2 G_2} \sqrt{\frac{KT_0^*(m_1 + m_2)}{2\pi m_1 m_2}}$$

where the quantities with the subscript 0 are the values outside  $r=r_0^*$  (outer wall);  $\Gamma=c_p/c_v$  is the specific heat ratio of the gas;  $\delta$ , Mo and D are the magnetic effect coefficient, the Mach number and the dimensionless diffusion coefficient. We use the following dimensionless equations:

continuity equations 
$$\rho ur = 1$$
 (2.1)

$$\rho_2(u + u_2) = G_2/G = \text{const}$$
 (2.2)

$$\rho_1 u_1 + \rho_2 u_2 = 0 \tag{2.3}$$

momentum equations

$$\varepsilon^2 \rho u \, \frac{du}{dr} + \frac{dp}{dr} = \frac{\rho v^2}{r} - \varepsilon^2 u \delta \tag{2.4}$$

$$\frac{1}{r} \left( \frac{dv}{dr} + \frac{v}{r} \right) = -\delta \left[ \frac{v_e}{r} + v \right] \tag{2.5}$$

energy equations

$$\frac{\rho u}{(\Gamma - 1)M_0^2} \frac{dT}{dr} = u \frac{dp}{dr} + \delta \left[ \left( \frac{v_e}{r} + v \right)^2 + \delta^2 u^2 \right]$$
 (2.6)

state equation

$$p = \frac{\rho T \left( 1 - \frac{m_2 - m_1}{m_2} \frac{\rho_2}{\rho} \right)}{\Gamma M_0^2 \left( 1 - \frac{m_2 - m_1}{m_2} \rho_{20} \right)}$$
(2.7)

diffusion equation 
$$\frac{d \ln y}{dr} = \frac{-\frac{m_2}{m_1}(1+y)(1/y-1/y_0)}{Dr\sqrt{T}} + \frac{\left(\frac{m_2}{m_1}-1\right)(1+y)}{1+\frac{m_2}{m_1}} \frac{d \ln p}{dr}$$
 (2.8)

The derivation of equation (2.6) uses Ohm's law  $\bar{j} = \sigma(\bar{E} + \bar{v}^* x \bar{B})$ . Equation (2.8) is derived from the diffusion rate equation<sup>3</sup>  $u_1^* - u_2^* = -D_{12} \frac{n^2}{n_1 n_2} \frac{dn_1/n}{dr^*} + \frac{n(m_2 - m_1)}{m_1 n_1 + m_2 n_2} \frac{dlnp^*}{dr^*}$  converted to dimensionless form.

 $u_1^* - u_2^* = -D_{12} \frac{n}{n_1 n_2} \frac{dn_1 n_1}{dr^*} + \frac{n(m_2 - m_1)}{m_1 n_1 + m_2 n_2} \frac{dn_2}{dr^*}$  converted to dimensionless form. It is apparent from equation (2.8) that the pressure and density gradients may result in relative diffusion of the light and heavy components; the diffusion produced by the density gradient tends to equalize it, while the diffusion created by the pressure gradient tends to separate the two components; thus the two types of diffusion work in opposite directions. Therefore it is necessary to produce high-speed rotation and establish a powerful radial pressure gradient in order to intensify the separation of the two components. This is the basis of our approach to separation of components of different mass by electromagnetic acceleration of an ionized gas.

Entry

conditions: 
$$r = 1$$
,  $\rho = \rho_0 = 1$ ,  $u = u_0 = 1$ ,  $T = T_0 = 1$ ,  $v = v_0 = 1$ ,  $\rho = \rho_0 = (TM_0^2)^{-1}$ ,  $u_i = 0$ ,  $\rho_i = \rho_{i0}^*/\rho_0^* = \text{const} (i = 1, 2)$ .

If the gas is injected tangentially through the outer wall, then the ratio of the radial velocity to the tangential velocity ( $\epsilon$ ) is much less than 1, so that that the term  $\epsilon^2$  in equations (2.4) and (2.6) may be ignored; thus we obtain

$$\frac{dp}{dr} = \rho v^2/r \tag{2.4.1}$$

$$\frac{\rho u}{(\Gamma - 1)M_0^2} \frac{dT}{dr} = u \frac{dp}{dr} + \delta \left( \frac{v_e}{r} + v \right) \tag{2.6.1}$$

From equations (2.1)-(2.6) and the entry conditions we obtain the rotation speed and temperature distribution:

$$v = \frac{(1+v_e)e^{\frac{\delta}{2}(1-r^2)} - v_e}{r}$$

$$T = 1 + \frac{(\Gamma-1)}{2} \mu_0^2 (1-v^2) + \frac{(\Gamma-1)M_0^2 \delta v_e (1+v_e)}{2} e^{\frac{\delta}{2}} (lie^{-\frac{\delta}{2}r^2} - lie^{-\frac{\delta}{2}})$$

$$lix = \int_{-\pi}^{\pi} \frac{dx}{1-r^2}$$
(2.9)

where

Using equations (2.7) and (2.4), by simple manipulation we convert equation (2.8) into

$$\frac{d \ln y}{dr} = -\frac{\frac{m_1}{m_2} (1+y)(1/y-1/y_0)}{rD\sqrt{T}} + \frac{\left(\frac{m_2}{m_1}-1\right)(1+y_0)\Gamma M_0^2 v^2}{\left(1+\frac{m_2}{m_1}y_0\right)rT}$$
(2.11)

To solve equation (2.11) by successive approximations, we select the equilibrium distribution  $(D \to \infty)$  as the zeroth approximation,

$$y^{(0)} = K(r) = y_0 \exp\left[-\int_r^1 \frac{\left(\frac{m_2}{m_1} - 1\right)(1 + y_0)\Gamma M_0^2 v^2}{\left(1 + \frac{m_2}{m_1} y_0\right)rT} dr\right]$$
(2.12)

Then the Nth approximation is

$$y^{(N)} = K(r) \exp \int_{r}^{1} \frac{\frac{m_{1}}{m_{2}} (1 + y^{(N-1)}) (1/y^{(N-1)} - 1/y_{0})}{Dr \sqrt{T}} dr$$
 (2.13)

The magnetic effect coefficient  $\delta$  expresses the strength of the effect produced by the magnetic field. The greater this effect, the greater the value of  $|\delta|$ . It is apparent from equation (2.9) that when  $\delta\!\rightarrow\!\infty$ , v reaches a limiting value  $-v_e/r$  which we will call the limiting velocity. Why is the rotary velocity subject to limitation? When the gas is accelerated by the electromagnetomotive force, the tangential magnetic lines of force produced by

motion of the ionized gas create a reverse electromotive force equal to  $v^*B_0$  which resists the motion of the gas; its direction is opposite to that of the impressed electromagnetic field and its magnitude is directly proportional to the speed. When the velocity v reaches a certain value the reverse electromotive force balances the impressed field, the current becomes zero, and the electromagnetic forces cancel, so that the gas cannot be further accelerated and reaches its limiting velocity. By suitably choosing the magnitude of the electromagnetic field, the limiting velocity can be made relatively large. For example, when  $r_0^* = 50$  cm,  $r_1^* = 10$  cm,  $r_0^* = 1,000$  G,  $r_0^* = 0.4$  m/sec and  $r_0^* = 50$  V/m, high-speed rotation of the gas at a limiting velocity of 2,500 m/sec can theoretically be achieved.

Calculations for Application to Isotope Separation

The magnetohydrodynamic solution for a two-component gas given above can be used to calculate the separation constant for an electromagnetic centrifuge separator. We define the homopolar separation coefficient as

 $\alpha = \frac{n_1/n_2}{(n_1/n_2)_0} = y_0/y$ ; from equations (1.12) and (1.13) we obtain the zeroth and Nth approximation values of  $\alpha$  as

$$\alpha^{(0)} = \exp \int_{r}^{1} \frac{\frac{m_{1} - m_{1}}{m_{1}} (1 + y_{0}) \Gamma M_{0}^{2} v^{2}}{\left(1 + \frac{m_{2}}{m_{1}} y_{0}\right) r T} dr$$
(3.1)

$$\alpha^{(N)} = \alpha^{(0)} \exp \int_{r}^{1} \frac{-\frac{m_{1}}{m_{2}} (1 + y^{(N-1)}) (1/y^{(N-1)} - 1/y_{0})}{Dr \sqrt{T}} dr = \alpha^{(0)} \eta_{N}$$
 (3.2)

where D < 0 and  $\eta_N$  < 1. In general, the larger |D| is, the closer  $\eta_N$  is to 1. In normal states, the stable isotopes Ne<sup>20</sup> and Ne<sup>22</sup> are present in proportions of 90.65 and 9.35 percent respectively, so that  $y_0 = 0.1031$ ,  $m_2/m_1 = 1.1$ , and  $\Gamma = 5/3$ ; choosing  $\delta = -\frac{1}{2}$ , -1 and  $-\frac{3}{2}$ ,  $M_0 = 0.3$  and 1.2,  $v_e = -10$ , and

D = -10 and  $-\infty$ , we obtain the results given in Figs. 2-4 (N = 2). As a specific example, when  $r_0^*$  = 50 cm,  $\sigma$  = 10 ohm<sup>-1</sup>-cm<sup>-1</sup>,  $r_1^*$  = 15 cm,  $\rho_0^*$  = 10<sup>-3</sup> g/cm<sup>3</sup>, B<sub>0</sub> = 1,000 G,  $u_0^*$  = 5 cm/sec, and  $\delta$  = -1, we find from Fig. 3 that if r = 0.34 we can obtain an isotope separation coefficient  $\alpha$  = 1.85 for concentrated Ne<sup>20</sup> at a flow rate of 4 g/sec. This indicates that electromagnetic centrifuge isotope separation gives rather high isotope separation values and a large yield. It is evident from equation (3.2) that for the same rotary speed, the lower the temperature the greater the separation coefficient. By using low temperature ionization or laser ionization of the gas, we can make better use of the advantages of electromagnetic centrifuge separator.

It is evident from Fig. 2 that when  $|\delta|$  is small, v increases rapidly with increasing  $|\delta|$ , but when  $|\delta| > 10$ , v decreases more slowly with increasing  $|\delta|$ . When there is a limiting velocity, if the impressed electromagnetic field is increased without limit there will be no improvement in the

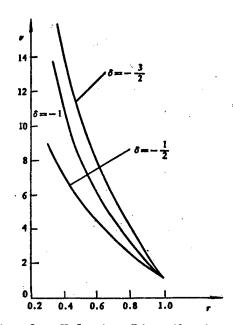


Fig. 2. Velocity Distribution D = -10,  $M_0 = 0.3$ ,  $v_e = -10$ .

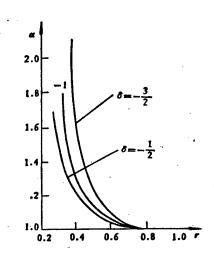


Fig. 3. Separation Coefficient Distribution

$$D = -10$$
,  $M_0 = 0.3$ ,  $v_e = -10$ .

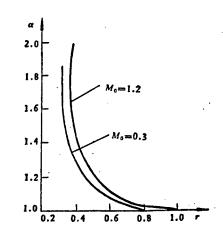


Fig. 4. Separation Coefficient Distribution

$$D = -10$$
,  $v_e = -10$ ,  $\delta = -1$ .

separation coefficient. In addition,  $|\delta|$  is inversely proportional to the yield  $\rho_0^* u^*$ , so that by suitably selecting  $\delta$  we can obtain rather high separation coefficients and rather large yields.

We thank Comrade Hu Wenrui [5170 2429 3843] for enthusiastic guidance and assistance.

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CSO: 4008/171

#### APPLIED SCIENCES

#### DEVELOPMENT OF ROBOT TECHNOLOGY IN SHANGHAI SURVEYED

Dalian ZUHE JICHUANG [MODULAR MACHINE] in Chinese No 5, 1983 pp 27-32

[Article by Lu Xueshi [0712 1331 6108] and Xu Huichang [6079 1920 2545], Precision Machinery Research Laboratory, Shanghai Industrial College: "Prospects for Application of Robots in China as Exemplified by Shanghai"]

[Text] Robots constitute a new field of science and a new technology which originated here and abroad in the last 10 to 20 years and are developing rapidly. They integrate the newest achievements in machinery, hydraulics, pneumatics, metrology, automatic control, computers and other scientific and applied technical fields. Many experts abroad even believe that development and improvement of robots will lead to the third industrial revolution.

In China, with its more than 1 billion people, there is much dispute over whether or not research and development in robot technology should be pursued. One view is that the main incentive for development of robots abroad is a lack of manpower and rising labor costs, while China has a large population and extensive manpower resources, and its current problem is finding extensive avenues for employment, so that with our population, the benefits would not outweigh the disadvantages. Another view is that China is technically backward and robotics is a sophisticated technology which is beyond the needs of our society in the current stage, so that it is not suited to China's circumstances, and it would be premature to pursue it.

But will research in robot technology be "unprofitable" and "premature?" Below we give our own views in connection with some facts from a survey of the Shanghai area.

China's Level in Robot Development and Applications and the Status of Their Use in Shanghai

China's first point-to-point robot was produced in Shanghai in 1958. At that time, foreign research in the field was also in its initial stage, and there was not a very large gap. But afterward, as a result of the extreme left ideological tide and the 10 years of chaos, development work was interrupted and we stagnated technically. A full 18 years passed before China's first robot technology dissemination station was set up in 1976, and by that time we were far behind foreign robot technology, lagging by about 20 years.

Following the smashing of the "gang of four" in 1976, there was considerable progress in robot research in China and in Shanghai. Its technical level can be summarized as follows:

- 1. China has already moved from importation of the robots required for manipulations in the nuclear power industry to their imitative manufacture and independent design, and has already developed small-series production capabilities. This favorably sets the stage for building nuclear power stations and developing other types of robots in China.
- 2. China already has the production capabilities and technical prerequisites for rational selection and introduction of various types of program-controlled robots in industrial branches and has already laid a good foundation for their use in a variety of fields.
- 3. Considerable research experience in the areas of high-precision teach-and-playback, multiple-linkage and magnetic-tape memory robots has already been acquired, which will shorten the time required for creating further reliable products for production use.
- 4. Research in such technical fields as robot vision, hearing, touch, computer control, artificial intelligence and the like has already taken its first steps.

#### Categories of Robots

There are many ways of categorizing robots. China currently uses the terms "anthropoid robot" [jigiren] and "manipulator robot" [jixieshou] and has not adopted the foreign term "robot" as such. Actually, the term "robot" as used abroad has no fixed definition, which leads to difference of opinion on the basic question of what a robot is.

If we provisionally use the broad classification of the technical development of robots given in Fig. 1, then when Japanese statistics report the existence of 100,000 robots, they are referring to categories A through H, which are also included in the Chinese use of the term, while in Europe and the United States only classes D through H or E through H are classified as robots.

$\int_{\mathbb{R}^{n}} H_{\bullet}$	Intelligent control	
G.	Computer controlled	1
F.	With various types of perception	]
E.	Imitative type	
D.	Program instructions changeable	
C.	Fixed-program control	
В.	Manipulator type	
, -	sto equipment without dent control systems	

There are also differences of opinion in China, but there is an apparent majority view that the categories from E upwards should be called "anthropoid robots," while those below should be called "manipulator robots." Whether this subdivision is in agreement with the country's requirements has yet to be determined. For these reasons, the statistics given on development and finer classification are still given in terms of manipulator robots [generally translated simply as "robots" below].

Shanghai is the part of China which uses the most robots and has them in the greatest concentration. Their applications have already extended to electrical and mechanical devices, light industry, the foodstuffs industry, the electronics industry, construction, textiles, and handicraft products. According to incomplete statistics, between 900 and 1,000 robots of about 350 types have been fabricated in Shanghai (including a few general-purpose robots).

More than 160 plants are using these types of robots. The electrical and mechanical products industry is the biggest and most extensive user of robots in Shanghai. According to 1979 statistics, about 450 robots of about 150 types were used in this industry, accounting for half of all robots in use in Shanghai. About 81 plants were using robots. Breakdowns in terms of branches of industry, number of degrees of freedom, types of power, coordinate type, control method and the like are shown in Fig. 2.

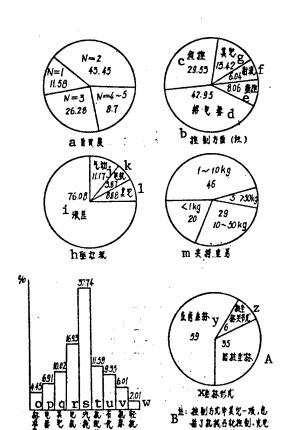


Figure 2.

祖序控制等等。

Key: a. Number of degrees of freedom

- b. Control method (see note)
- c. Program control
- d. Relay
- e. Numerical control
- f. Jet control
- g. Other
- h. Type of drive
- i. Hydraulic
- j. Pneumatic
- k. Electromechanical
- 1. Other
- m. Carrying capacity
- n. Comparison of various industrial branches
- o. Standard parts
- p. Electrical equipment
- q. Other
- r. Electrical machinery
- s. Automotive and tractor
- t. Machine parts
- u. Petrochemistry
- v. Machine tools
- w. Light machinery
- x. Type of coordinates
- y. Rectangular
- z. Polar
- A. Cylindrical
- B. Note: Other types of control include mechanical cams, optoelectronic program control

Areas Currently Suitable for Development of Robot Technology

Is it currently "unprofitable" and "premature" for China to develop and apply robots? Such a broad generalization is clearly incorrect. We must understand clearly that in addition to being able to replace human labor, robots can perform labor of which humans are incapable; this is one reason why, even with our large population, we must use and develop robots and must not stop with relatively simple manipulators. In addition, it should be pointed out that if we import and develop robots in a realistic manner (rather than doing it blindly and for its own sake), we will be able to raise China's technical level and gain time, as well as speeding up our economic and technical reorganization and thereby shortening the time required for modernization. Below we briefly describe results that have been achieved in Shanghai's practical application of robots.

1. Many important types of modern industrial production require robots. Without them the manufacturers will not be able to achieve their production objectives or even to produce their products; therefore the use of robots has great viability and extensive prospects. For example, development of large-scale integrated circuits and other electronics components and the production of certain contraceptive products require the avoidance of direct contact by humans and are produced under sealed conditions, i.e. human breath must not come in contact with the products during the manufacturing process. When we use human labor in the production of integrated circuits, our acceptance rate is low. In the United States, IBM uses robot technology for totally sealed production, and the product acceptance rate has reached 100 percent; not only is product quality assured, but the products are reliable, labor productivity is increased and production costs are decreased, so that the products are highly competitive.

The petroleum drilling bits produced by the Shanghai No 1 Petroleum Machinery Plant are urgently needed for the development of China's petroleum resources. one drill bit blank weighs over 20 kg. The plant had always used manual labor in single-machine process-flow production, installing the cutters one by one in blanks containing five holes. Positioning accuracy was poor and the alignment to the axes of the inner holes was inaccurate, so that our products were inferior to similar foreign products and their manufacture involved a good deal of physical labor. Thus we could not meet our petroleum front's drilling footage requirements. In a technical modernization effort last year, the plant installed a double-gripper robot with tactile capability and set up an automatic drill bit blank processing line using robot manipulators, which made it possible to use a standardized chuck to grasp the drills; this automated machining assured product precision and allowed the acceptance rate to be increased greatly, in addition to which the number of personnel needed to tend and manage the entire line decreased from 5 to 1 or 2.

An alloy with a micropore structure similar to glass which has a disordered spatial arrangement of its atoms is a corrosion-resistant material with special magnetic properties and mechanical strength urgently needed by the country. For example, the noncrystalline alloy FeCrPC<sub>7</sub> has a corrosion resistance three times that of 18 percent Ni - 8 percent Cr stainless steel, and its magnetic properties are comparable to that of Fe-Ni permalloy. But this noncrystalline

material must be produced by fusing grains of the metals at 1,200°C and high pressure, cooling them by 1,000°C per second to -50°C and depressurizing them to vacuum conditions. Thus, manual operation by humans is impossible. Other operations, such as liquefying old rubber tires, treating nuclear waste, welding in deep water, radiation monitoring and the like, can be performed by robots in ways that are beyond human capacities.

2. Robots are a way of balancing electricity use and increasing output value per unit energy consumption that must not be ignored.

Rational use of electricity is currently of concern to everyone. Shanghai has long been a relatively advanced part of the country in terms of its thorough use of energy resources, producing about \$1,100 worth of output per ton of standard coal. But this is a low figure in worldwide terms; it is only 60.4 percent of the value achieved in Japan and 55.6 percent of that achieved in Germany; while the value achieved in France is almost double that achieved here, and Shanghai is also 13.7 percent below the figure of \$1,260 achieved in India. Shanghai's energy conservation achievements in recent years have been realized primarily by readjustment of the economic structure and by making energy-saving improvements on the main pieces of improvement. Another method is to intensify management, balance energy consumption, level out peaks and valleys and expand nighttime power consumption. The Shanghai No 9 Radio Plant's good experience with nighttime use of robots has great value. Night operations can be conducted with only a few supervisors. The plant has fabricated more than 10 hydraulic and numerically controlled plastic injection machine robots, 6 punching machine robots, and 24 robots for pressure forming of metal. In daytime there are many workers and their labor productivity is somewhat higher than that of the plastic injection robots, so that in daytime humans and robots are used simultaneously; in the swing shift and night shift, the robots are used, along with a few workers to supervise and tend them, which has increased the shop's total output. In order to increase the output value per ton of standard coal, the Office of Electric Power has established different rates for daytime and night in the hope that enterprises will use electric power at night and not waste additional fuel. Unmanned factories, equipped with machines, in which "we see few people and hear only the sound of the machinery" and in which robots engage in production in place of humans in the still of the night are of great importance for the rational use of energy.

3. Robots are an excellent way of increasing labor productivity and output.

A socialist country's only way of raising the people's standard of living is to continuously raise its production standards and increase labor productivity per worker so as to produce huge amounts of social wealth. Shanghai-produced sewing machine needles have long been polished by human workers; this technology was obsolete and the needles had long been a scarce product on the markets. The output of the Shanghai No 1 and No 2 sewing machine needle plants accounted for almost all of Shanghai's sewing machine needle production, A few years ago, the No 1 plant developed an automatic needle polishing line consisting of 5 robots with 3 degrees of freedom, which not only decreased the number of workers needed from 7 to 1 or 2, but also increased daily output by 20 percent from 8,000 packages to more than 10,000. After the

successful development at Plant No 1, Plant No 2 immediately improved and upgraded its machinery on the basis of this experience, added two degrees of freedom (arm extension and retraction, right and left movement), and put an automatic needle production line consisting of five machines with 5 degrees of freedom into operation, for which it received an Office of Light Industry award for excellent equipment design. It is obvious that robots have great viability. The Shanghai Tractor Plant used an automated process line containing 11 hydraulic program-controlled robots with 4 degrees of freedom for milling the ends of 25-kg semiaxles as well as turning, rolling of screw threads, cold forging of splines and milling of keys; this increased productivity by a factor of 7 to 9. Certain rather large plants in Shanghai have already introduced automated lines for most machining, most axle-type and disk-type parts, so that the application for robots has become a necessity and has reached a relatively mature stage. For example, robots have already become essential components in the machining of compressor crankshafts at the Shanghai Refrigerator Plant, valve stems at the Shanghai No 5 Valve Plant, DZO axle ends at the Shanghai Special Electromechanical Machinery Plant, gas cylinder covers at the Shanghai Drive Machinery Plant, SH-760 vehicle engine separator pumps at the Shanghai Motor Vehicle Engine Plant and the like and have consistently given good service.

4. Protecting the workers' legitimate interests and protection of labor are an unswerving policy of Chinese socialism.

After the Taikang Food Products Plant in Shanghai received and packaged food products, it had to quickly place them in the freezer for quick-freezing. quick-freezer was bitter cold, with temperatures below -20°C. In serious cases, prolonged work in this environment could cause rheumatism and crippling of the entire body. Following its development of a numerically controlled refrigerator robot in 1980, the operations of transporting food products into the freezer, recognition of locations, movement, and removal of goods were automated. This was the first time that freezers not requiring humans to operate them had been developed in China; the productivity per hour was potentially increased to 150 trays per hour. The Shanghai Measuring and Cutting Tools Plant carried on quenching of large quantities of high-speed tool speed in large lots, with high quality requirements, but the high-temperature steam produced by the salt-bath furnaces during the quenching process was harmful to humans. The plant installed five pneumatic program-controlled robots to control four modular salt-bath lines with temperatures as high as 600-1,300°C and instituted automatic quenching of tools (which weighed 30 kg), thereby increasing its productivity by a factor of 2 to 3 and cutting manpower requirements in half while making it unnecessary to expose personnel to a hightemperature poisonous atmosphere. The Shanghai No 4 Standard Parts Plant's galvanizing shop was filled with chemical vapors and the parts (screen) to be lifted out were heavy, weighing up to 100 kg. After the plant developed a hydraulic numerically controlled galvanizing robot its situation was completely altered. Last year the Shanghai Yaohua Glass Plant developed a kilnentrance robot which could be remotely operated by workers, thus avoiding the scorching environment at the kiln entrance. Hydrofluorcyanic acid is an intensely poisonous substance. Last year the Shanghai No 9 Vacuum Tube Plant introduced a rectangular-coordinate washing manipulator with 4 degrees of

freedom into its process for acid washing of glass picture tube casings, so that personnel were entirely removed from contact with the acid and output was increased to 60 tubes per hour, exceeding the output when human workers were used. The iron core oxide coating work area in the Shanghai Motor Vehicle Electric Machinery Plant was a high-dust environment which was seriously harmful to health. The plant introduced an oxide coating flow line using a bellows-type pneumatic robot which removed workers from the dusty environment. Thus it is evident that extreme environments not suitable for humans are important areas in which China can use robots.

- 5. We are a large country and we must gradually establish and develop our marine and space capabilities, which offers an important area for the use of robots. The exploration robot manipulator developed by the Shanghai No 3 Machine Tool Accessories Plant for the Office of Oceanography has been installed on the seagoing research vessel Kantan I and has proven useful. A certain research institute in Shanghai is currently doing design research on a robot, intended for work at the sea bottom, which can interchange several different types of jaws. The manually controlled ocean robot developed by institute No 704 for recovering intercontinental ballistic missiles from the ocean is an indication of the strategic significance of China's development of robots.
- 6. Remote border provinces such as Qinghai, Ningxia, Xizang, Xinjiang, Guizhou and Gansu are rich in resources, but economically backward and urgently in need of development. For example, the industrial output value totaled only 1.39 billion yuan in Qinghai, 1.36 billion yuan in Ningxia, 150 million yuan in Xizang and 3.14 billion yuan in Xinjiang, equivalent to 2.22, 2.17, 0.24, and 5.01 percent respectively of Shanghai's output value of 62.6 billion yuan. Thoroughly utilizing these areas' rich material and mineral resources to develop their economies is of great strategic importance to China. Because the border regions differ from the coast, having sparse populations and insufficient manpower and in particularly lacking workers with technical skills, these provinces are critical areas for the introduction and utilization of robot technology. This will not only provide a more advanced starting point, and upgrade these areas' production technology, but in addition can allow focused development and comprehensive utilization of their mineral resources in a relatively short time, thus rapidly altering their economically backward state.
- 7. Military uses.
- 8. They liberate workers from heavy and tiring operations.

At the Shanghai scientific and technical exchange meeting held in March 1983 the sewing machine industry proposed a key effort in the use of robots for removing burrs from the blanks for sewing machine cases. Because sewing machine cases weigh up to 7 kg and are manipulated by humans, machining them with emery wheels produces large amounts of dust and causes aching limbs and backs; thus the workers fervently wish to get manipulators into operation immediately. During precision casting, alloy additions are added to the melt at a high temperature; this work is extremely heavy and unsafe. In addition, the quality of the castings is extremely variable. The Shanghai Instrument

and Steel Molding Plant developed a hydraulic automated pouring robot with 4 degrees of freedom which was combined with a pressure casting machine, which satisfied output requirements and mechanized pressure casting, and in addition freed the workers from heavy physical labor. The Shanghai Steam Turbine Plant's turbine blade die forgings weigh as much as 80 kg each and manipulating them is extremely toilsome. Use of a cylindrical-coordinate program-controlled robot with 3 degrees of freedom at the steam hammer was welcomed by the workers, and the device has given continuous good service to date. The development of punching machine robots in Shanghai has a long history. For example, the Shanghai May 1 Electrical Machinery Plant uses 60-ton and 100-ton punching machine robots to produce electrical machine rotor plates and carbon steel rings; the Shanghai Electrical Machinery Plant uses a DC-motor-driven 250-ton punch press and robot to produce electric motor stator plates weighing up to 2.5 kg; the Shanghai Standard No 1 Standard Parts Plant has a multiple-position cold-heading robot, and the No 2 Standard Parts Plant uses a robot on the 100-ton punch press for M12-30 double ended studs; all of these devices have been in normal operation for at least 4 or 5 years, functioning stably, safely and reliably, and have achieved rather high output, solving the long-standing problem of breaking of fingers in the press, the threat of what was called the "tiger's mouth," so that the workers have been grateful for the robots. The Shanghai Machinery Plant produces circular saw blades weighing up to 40 kg; the manual labor involved in quenching them was very heavy. After a suspension-type quenching robot was developed, the workers only had to maintain and tend it, and the quality of tempering became rather consistent. The No 2 Welding Plant produced iron glands; in the past these devices were produced on a single machine, and since each piece weighed as much as 60 kg, so that the effort involved in handling them was naturally very great. After a manipulator was developed and integrated into an automated production line, the production situation was completely transformed.

It is evident from the examples from Shanghai quoted above that considering the rational development and application of robot technology in China to be unnecessary because of large population, or premature, or unsuited to China's conditions, simply bespeaks incomplete analysis and understanding. But to neglect the factors of China's large population and extensive manpower and blindly and indiscriminately expend large amounts of money to develop robots merely in order to replace manpower would indeed be unprofitable.

Problems in the Use of Robots in Shanghai

Because the development of program-controlled robots in Shanghai has been basically mastered, there are many cases of their normal use in such areas as electroplating, forging, punching, plastics injection molding, metal cutting, pressure casting, heat treatment, measurement and the like. But there are still a good many problems involving their use that need to be solved. For example, although more than 160 plants in Shanghai are already using robots, this is only 2 percent of the 8,017 industrial enterprises in the city, which indicates that there is still considerable room for their dissemination. In addition, there are a variety of problems with the 900-1,000 robots that have already been developed. As Fig. 3 indicates, fully 46 percent of robots are idle or have even been dismantled for various reasons.

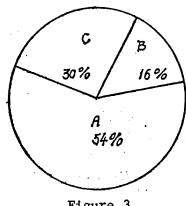


Figure 3.

Providing normal service Key: a.

- Usable but not in use Ъ.
- Idle or dismantled because of problems

Thus if we do not find out the causes and overcome them, this will hinder the application and development of robot technology in China. Overall, the problems are of the following types.

- Because China has no specialized plants to produce manipulators, the manipulators currently in use are all built in-house. Some of the manipulators were built hastily and are not in accordance with requirements, or have deficiencies in the original design, or do not operate stably or have many malfunctions and poor reliability, so that they do not give normal service. For example, the robot used for quenching heat-treated automobile springs at the Shanghai automotive steel leaf spring plant had 5 degrees of freedom and used step selector program control. Each of the workpieces (steel automotive leaf springs) weighed 40 kilograms, so that this robot was sorely needed in production, but because of its inaccurate positioning, the robot could not grip and transport the workpieces in a way suited to the quenching process; as a result, it was taken out of service. The crankshaft milling robot at the Shanghai Automotive Engine Plant and the automatic diesel engine bezel turning robot at the Shanghai Diesel Engine Plant were taken out of service because the impact of the pneumatic parts often damaged the cutting tool when the part was positioned. The copying lathe robot developed for production of electric motor axles at the Shanghai Gexin Electrical Machinery Plant was also taken out of service because of poor manufacturing precision and inaccurate positioning.
- Poor quality of parts and components results in too short a mean time between failures, so that the manipulators do not give normal service. For example, the rubber-diaphragm robot for handling silicon steel plate on the 200-ton punch press developed by the Shanghai No 5 Electrical Machinery Plant and the automatic turning manipulator for 25-kg cranks at the Shanghai Lixin Electrical Instrument Plant were abandoned because of problems with the electrical instruments and hydraulic components which resulted in poor positioning accuracy. The program-controlled robot with DC drive motors developed by the Shanghai Electrical Machinery Plant was first used on the 160-ton punch

press to produce 2.5 kg electric motor stators, but because of problems with the electrical components it did not give good service and was ultimately dismantled. The program-controlled 165F robot with 4 degrees of freedom for use in low-pressure casting of gas cylinder tops at the Shanghai Gas Turbine Plant was dismantled because overheating of the hydraulic components affected its operation. The hydraulic press tending robot at the Xincheng Automotive Parts Plant has been idle for 2 years because the numerical control unit broke down shortly after development.

- Production of "teach and playback" robots has not yet been organized and there is a lack of modular robots. As a result, the robots in use lack the necessary versatility and cannot be adapted to multiple-variety, small-lot production; if product specifications change or a product is discontinued, the specialized robots become worthless. The workpiece positioning and removal robot used for tractor and automotive semiaxles at the Shanghai Electrical Equipment Forging Plant (for 20-kg workpieces) and the gear blank positioning and removal manipulator used for the Fengshou 35 final reduction gear blanks (workpieces weighing 18 kg) at the Shanghai Tractor Accessories Plant consistently gave good service and good results, but ultimately when the products were readjusted the original production line could not be adapted to the changed circumstances and the robots were taken out of service. The axle bearing packaging robots developed by the Shanghai Axle Bearing Plant was designed for the 305 and 206 axle bearings and gave good service. But this plant produces a rather large variety of axle bearings and this robot could not be adapted to them, so that it ultimately did not give the proper service. washing robot with 4 degrees of freedom at the Shanghai Combined Clamp Plant was well received, but when the production assortment was changed it eventually became worthless. A numerically controlled cylindrical-coordinate robot with 4 degrees of freedom in the hot punching shop at the Shanghai No 4 Standard Parts Plant was developed at the cost of considerable effort and used with a special-purpose hydraulic forming machine; it gave good service, but when the size of the product was decreased it could not be adapted and was abandoned. The bakelite forming press robot in the Shanghai Electrical Bakelite Plant was also insufficiently adaptable and was taken out of service when there was a rather major change in the product.
- 4. Because robots have lacked the proper strength, visual capabilities, and automatic microscopic distance and similar compensating features and have had poor adaptive capabilities, they have not been able to give normal service under real production conditions and even damaged themselves or the machines with which they were designed to work. The gear blank robot at the Shanghai Automotive Gear Plant was reliable and rather efficient when used for reaming gears, but after it was put into service it was found to be too simple, and the reaming quality did not meet the blueprint requirements, so that it was necessary to add an automatic compensating mechanism. The general-purpose cylindrical-coordinate manipulator with 5 degrees of freedom produced by the Shanghai No 2 Machine Tool Accessories Plant and the JS-1 polar-coordinate general-purpose robot developed by the Shanghai Tractor Gear Plant have both been exhibited, but have never been usable in production because control is too poor, they actually cannot be positioned as desired, and compensations cannot be made, to say nothing of their lack of adaptive capabilities. The forging robot

produced by the Shanghai Machine Tool Cutting Tip Plant cannot grip the work-piece if its dimensions or position are changed, with the result that it cannot be used as it should. In the Shanghai No 1 Electrical Wire Plant's final-design copper coil manipulator, control is implemented through machine perception based on a picture tube, but because of production failures in the production of the tubes, the device cannot be used. Thus it is evident that the study and development of measuring components is extremely important for assuring that manipulators will operate normally under real production conditions.

- 5. Because of failure to provide some necessary accessories for robots (which take account of the shape, weight, sequence machining route, precision, positioning and the like of the workpiece), robots have been unable to adapt to production needs. A robot used by the Shanghai Machine Tool Plant for workpiece feed and removal in the grinding of main axles proved inaccurate in positioning and had to be supplemented with a support frame and other accessories. The automatic robot for tinning radiators at the Shanghai Automotive Parts Plant was well designed, with up-down, left-right and forward-back movement and the arm assembly could turn over easily, making it able to replace manual labor in transporting radiator cores weighing up to 80 kg for tinning, washing and the like and in addition was able to remove the workers from a high-temperature environment containing poisonous gases. But because of disagreements, the plant failed to spend the material and labor resources needed to add the requisite accessories, with the result that the robot was difficult to use and its output did not meet requirements, so that after completion it was dismantled by the leadership. A hydraulic circular-coordinate programcontrolled robot with 4 degrees of freedom developed by the Shanghai Heavy Locomotive Plant was usable, but because of chaotic management during the period of the "gang of four" the problems of providing the necessary accessories and adjusting production layout were never solved and it was ultimately disassembled. A rotor plate robot for the 160-ton punch press at the Shanghai Renmin Electrical Machinery Plant was simple in design and reliable in operation, but because a suitably stable gas source, silicon steel plate positioning and materials transport were not provided, it did not give proper service. Because the robots used in the Shanghai punch press industry were not designed as complete sets of equipment, their effectiveness was lowered and many of them have been dismantled.
- 6. The production layout has not taken complete account of the capabilities and characteristics of the robots used. In many cases, robots have been used with the processes, equipment and production lines that were used previously with human labor, making it impossible to coordinate their work. For example, the feed and removal robot for gear blanks at the Shanghai Tractor Gear Plant, the DSY-01 spot welding robot used at the Shanghai Electric Welding Machinery Plant, and the motor vehicle floor spot welder used in its initial design at the Shanghai Motor Vehicle Plant all cost more than 200,000 yuan each, but when they were brought into the plants it was found that they could not be adapted to existing production lines, so that they have been idle for several years. Instances of the opposite kind, in which a comprehensive layout was arranged, giving excellent results, are also numerous. For example, the Shanghai Standard Parts Company uses robots rather widely and achieves rather

high output; as of last year its 5 plants had already put 20 robots into use. and this year, as output increases, the number will be expanded considerably. The respects in which they have been successful include not only reliable design, simple and rapid operation, and use of spring-type clamps in most of the grasping mechanisms, but also rational production layout centered on the cold heading units, yielding excellent results. The Changning, Zhongguo, Shanghai and Hongxing axle bearing plants of the Shanghai Machine Parts Company are nationally known for the output and quality of their axle bearings. The technical requirements imposed on axle bearing production are rather stringent. These plants readjusted their production structure several years ago and built an extensive series of automated production lines equipped with robots for such processes as extra-high-precision grinding of inner and outer axle bearing channels, inner circular grinding, packaging, turning and grinding of the inner race, punching, turning of the outer race, grinding of inner rings and outer slots, maintaining proper configuration, reaming of inner race, turning over inner rings, and cutting of channels in small bearing races, thus achieving mechanization and automation of production and assuring consistent high output and excellent quality of axle bearing production. The number of robots in use in the four plants is as high as 48. At the Xincheng Automotive Parts Plant in Shanghai the output and efficiency of the punch press robots were inferior to those of human operators, so the plant changed the production layout for punching of the Jiefang lamp housing, redesigning ordinary punch presses into 6-position presses and producing robots for the lamp housings, thereby achieving results much superior to those of human operators; as a result, for the past 5 or 6 years the manipulators have been consistently given normal operation on the production line.

Some Views on Development of Robots in China

- 1. In developing robot technology, China should not aim simply at replacing manpower.
- 2. In applications, the necessary auxiliary equipment must be provided in accordance with the characteristics of the robots, and various types of program-controlled robots should be put into wide use, rather than indiscriminately aiming at sophisticated robots; this approach will yield the best results. Even in Japan, which uses the most robots, robots of this type account only for somewhat more than half of the 100,000 robots in use, and only 14,000, or 14 percent, have magnetic tape or drum memory and a teach and playback capability. There are about 4,000 of these sophisticated types of robots in the United States, only 20 percent of the total number.
- 3. It is particularly important to develop modular robots in China. The progress made in this area by the Dalian Research Institute of Modular Machine Tools and the Jilin Research Institute of Machine Tools has provided effective experience for China's development and use of modular robots.
- 4. We should change our initiative production approach and import key parts and components and production technologies in order to win time and to accelerate the development of sophisticated robots. We have carried out imitation research in teach and playback robots for 4 or 5 years in almost

10 different organizations and spent 2 or 3 million yuan on the work, but we have not yet made a breakthrough and put them into production and use. The situation in China is that our design and manufacturing capabilities are adequate, but the key problem is that we lack such basic elements as measurement, drive, and control components or that their quality is not up to requirements. If this problem is not resolved, it will be difficult for us to produce sophisticated robots with magnetic tape memories. And if we did make a herculean effort and developed such devices, it would be difficult to organize their series production. But mastering the technologies for producing such sophisticated robots is important for national defense, scientific research, education, public health and several other parts of the national economy.

- 5. We should intensify research and development in such areas as tactile and visual perception, "knowledge and concepts," computer signal processing, natural language comprehension, goal-directed planning, and reception of non-visual information. This technical reserve is of great strategic importance for carrying out the four modernizations and decreasing the gap which separates us from the world state of the art.
- 6. We should establish an effective center for theoretical research and technical development of robots within institutions of higher education or scientific research organizations.
- 7. We must intensify international specialized exchange activities.

8480

CSO: 4008/132

#### APPLIED SCIENCES

#### NEW TELECOMMUNICATIONS OPTICAL FIBER DEVELOPED

OW130853 Beijing XINHUA in English 0703 GMT 13 Jan 84

[Text] Beijing, 13 January (XINHUA)—Chemists at the Chinese Academy of Sciences have developed a new optical fiber for experimental use in telecommunications, academy president, professor Lu Jiaxi announced here today.

President Lu said this was done under the guidance of the academy's academicians—an honorary title given to China's leading scientists.

Lu Jiaxi said that since its fourth session in 1981, the academicians have headed or guided many of the key research projects of the academy.

Academicians have been organized to appraise institutes' research findings or map out major research programs for the academy or the state or to study the feasibility of some key projects.

Many of their opinions concerning, for example, application of nuclear technology, development of integrated circuits and computers, marine engineering, separation of isotopes with lasers have won the attention of the central government and some already been adopted, he said.

The academy's chemists have devised a new polyurethane grouting material for use in the Gezhouba Dam against leakage. It stood the tests of Yangtze River's rare high crests last year.

They have also found new processes to extract vanadium from the vanadium-titanium-iron ores at Panzhihua in Sichuan and recover more copper, lead, zinc and gold.

Geologists have carried out research of geological structures, sediments and the morphology of China's seas and the nearby high seas and analyzed the prospects of oil and gas deposits. Major attention is now focused on the possibility of oil and gas reserves in the carbonate rocks of Southwest China, mainly in Guizhou, he noted.

Biologists have been working on research in ecology and comprehensive prevention of cotton boll weevils, the production of a vaccine against B hepititis by genetic engineering, preservation of fruit and vegetables, he said.

Mathematicians have worked out a model for the optimum national distribution of crude oil, which will save an estimated amount of 430 million yuan. Results in operations research have provided the optimum theoretical base for designing China's large open-cut mines. This will be applied to China's 70 major projects. This alone will save China tens of millions of foreign currency, he said.

CSO: 4010/35

#### LIFE SCIENCES

MAJOR MEDICAL SCIENCE ACHIEVEMENTS MADE

OW101406 Beijing XINHUA in English 1325 GMT 10 Jan 84

[Text] Beijing, 10 Jan (XINHUA)--Beijing tackled 109 major projects in medical science in 1983, some of the results reaching advanced world levels, according to the Municipal Bureau of Public Health.

The achievements included solutions to a number of basic theoretical problems and discovery of new methods for preventing and treating common and recurrent diseases.

The Municipal Public Health and Epidemic Prevention Center succeeded in making a highly-efficient preparation for typing vi bacteriophage of salmonella typhi, a project universally regarded as important for tracing the sources of infection and the media of the spreading of typhoid.

The Beijing Lung Tumour Research Institute has conducted comparative studies of HLA (herd leucocyte antigen) among some of China's nationalities and areas. Based on an abundance of data collected through 190,000 experiments, the researchers found that there are marked differences between HLA from people in northern and southern China as a result of geographical differences. They also drew up the first map showing HLA in China, thus contributing to the worldwide research in this field.

In combating common and recurrent diseases, some institutes achieved good results in studying the incidence, geographical distribution, causes and degrees of harm of 10 nervous system ailments. The Chaoyang Hospital found a way of curing acute gas poisoning by using high-pressure oxygen, and its curing rate reached 87.5 percent.

cso: 4010/33

LIFE SCIENCES

#### **BRIEFS**

SHANGHAI ADVANCED MEDICAL ANALYZER--Shanghai, 22 Jan (XINHUA)--An advanced medical electrolyte analyzer for testing blood passed scientific assessment by a panel of specialists here yesterday. Requiring just a drop of blood taken from the fingertip, the instrument has been put to clinical use in six hospitals in Shanghai and Beijing, making a total of 1,448 tests. The meter, weighing 15 kilograms, can analyze a blood sample in 45 seconds. Previously, a lot of blood taken from the vein had to be used for the same purpose. The old type of instrument involved a complicated, time-consuming process. "The results show that it has reached advanced levels of similar foreign products," a spokesman for the panel said. The spokesman said this marked a new breakthrough in China's research in clinical biochemical analyzing meters and supermicro-analytic technology. Children who suffer from diarrhea are likely to fall victims to electrolyte disturbance. Death would be induced without quick understanding of the content of potassium, sodium and chlorine ions in their blood and timely infusion. It was made by scientists at the Shanghai Institute of Medical Apparatus. [Text] [OW220650 Beijing XINHUA in English 0643 GMT 22 Jan 84]

CSO: 4010/36

#### **PUBLICATIONS**

#### ANNUAL INDEX TO LASER JOURNAL PUBLISHED

Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese No 12, 20 Dec 83 pp 870-876

[Text] Annual Cumulative Contents of Volume 10, CHINESE JOURNAL OF LASERS (1983)

	No.	Cum. No.	Page
Diffraction of a blazed grating illuminated with a Hermit-Gaussian beam	1	73	1
Simulation calculation of light propagation	1	73	8
Study of CARS application in chemistry	1	73	13
Quick measurement of spectral distribution and efficiency of $\mu s$ level flash-lamp			
using OMA-2 system	1	73	17
Investigation on drilling by ultrasonic modulation of laser pulse spikes	1	73	20
Experimental study on the deposition of ThF4 protective film and its radioactive			
protection	1	73	26
Enhanced absorption of CO <sub>2</sub> laser by silicon	1	73	<b>2</b> 8
Grating dispersion cavity for CO lasers	1	73	30
Waveguide effects in the waveguide dye laser	1	73	<b>3</b> 2
Experimental study on phase conjugate of multimode TEA CO <sub>2</sub> lasers	1	73	<b>3</b> 8
Graphite for Ar+ laser and its treatment	1	73	<b>4</b> 2
Microstructure of hot-forged infrared laser window mrterial KCl	1 ,	73	45
Liquid-surface ultrasonic holography	1	73	49
Polarization characteristics of stripe geometry GaAs-Ga <sub>1-x</sub> Al <sub>x</sub> As DH lasers	٠.		
with masked and selective thermal oxidation structure	2	74	65
Relationship between transient and stationary stability in semiconductor stripe-			
geometry DH lasers	2	74	70
A Nd-doped phosphate glass laser disk amplifier of 200 mm clear aperture	2	74	74
Enhanced-impulse effect of TEA CO <sub>2</sub> lasers	. 2	74	77
Study on two-photon dissociation of HgI2	2	74	81
Investigation on hyperfine structure of 127I2 by saturated absorption spectro-			
scopy at 633 nm	2	74	85
Four-wave mixing effect in the existence of SBS field	2	74	88
A new method for measuring radial intensity distribution and diameter of the			
Gaussian beam	2	74	90
Ultrahigh speed photography of ultrashort optical pulses	2	74	93
Resonant coupling between EO and AO effects of LN modulators	2	74	97
Bending characteristics of point holograms	2	74	101
Vibration analysis of hydraulic engineering by holographic interferometry	2	74	105

	No.	Cum. No.	Page
Interferometry of laser induced birefringence in glasses	2	74	110
Angle scattering of multilayer dielectric thin films	2	74	113
Photodiode line array for laser and optical display	2	74	117
Numerical modeling of pulsed F <sub>2</sub> /H <sub>2</sub> chain reaction lasers	3	75	129
CW CO <sub>2</sub> laser annealing of arsenic implanted silicon	3	75	136
Electron energy distribution in CO <sub>2</sub> laser mixtures	3	75	<b>14</b> 0
Quantum efficiency and absorption recovery time of pentamethylidyne and			
undecamethylidyne dyes	3	75	143
Study on open-circuit output voltage of Blumlein exciting circuit for N2 lasers	3	<b>7</b> 5	147
Study on X-ray preionized repetitive pulsed excimer lasers	3	75	152
A simple compact XeCl excimer laser with corona preionization	3	75	156
Wavelength-selection of off-axial grating cavity for line-tuned lasers	3	<b>7</b> 5	159
Spectral characteristics of emission from stripe-geometry GaAs-GaAlAs double			
heterostructure lasers	3	<b>7</b> 5	164
Study of all metal structure argon lasers	3	75	168
Investigation on characteristics of repetitive short pulse xenon lamps	3	75	171
Cyclical null-drift and multimode coupling for a four frequency ring laser			
gyro	3	75	175
Precise measurement of wavefront curvature of large diameter laser beams			
using lens array	3	75	179
Calculation of corrected temperature rise for laser calorimeters	3	75	183
Subnatural linewidth two-photon spectroscopy	4	76	193
Study on intracavity frequency doubling by Mg: LiNbO <sub>3</sub> for an acousto-optic			
Q-switched Nd:YAG laser	4	76	198
Gain and saturation characteristics of an X-ray preionized avalanche discharge		* * : .	
XeCl laser	. 4	76	201
Two-pass SHG produced by a LiNbO3: MgO crystal in the resonator of a Q-			
switched YAG laser	4	<b>7</b> 6	<b>2</b> 0 <b>5</b>
Polarization characteristics of lasers with a LiF:F <sub>2</sub> Q-switch	4	76	207
Measurement of the conversion efficiency and tuning range of some 1,4-bis			
[\beta-substituted phenyl] benzene derivatives	4	76	210
A selective branch CO <sub>2</sub> laser operating in sequence bands	4	76	212
Raman-resonant four-wave parametric mixing process in rubidium vapour	4	76	215
Diagnosis and compensation of wavefront distortion of laser beams	4	76	220
Talbot shearing interferometer and its application	4	76	225
Measurement of refractive index profile of Ti-diffused LiNbO <sub>3</sub> plane waveguides	. 4	76	230
Graded refractive index waveguides with metal-cladding	. 4	76	232
Research on propagation characteristics of modes in photoresist-glass planar			
optical waveguides	A	76	925
Multi-point contact MIM	4	76	235
	4	76	238
Selection of single pulses with an all avalanche transistor driver	4	76	242

	No.	Cum. No.	Page
Highly reliable and accurate power supply for repetitive pulsed lasers	4	76	246
Phase conditions for free electron lasers	5	77	257
Measurement of vibrational displacement and stress of a blade by time-average	,	•	
holographic interferometry	5	77	261
Experimental study on stability of F <sub>2</sub> centers in oxygen doped LiF crystals	5	77	269
A Nd-glass rod laser amplifier using moving input laser beam	5	77	274
Investigation on semiconductor Si doping by laser irradiation	5	77	277
Investigation on tunable lasers pumped by an excimer laser	5	77	281
A tunable LiF:F <sub>2</sub> color center laser	5	77	283
Parametric characteristics of an electrically initiated HF laser	5	77	286
A CW tunable CO laser with two wavelengths	5	77	<b>2</b> 89
Measurement of refractive index gradient of inorganic liquid laser system Nd.	•		
$POCl_3/ZrCl_4$ and the effect of some additives on its $dn_D/dt$	5	77	291
Investigation of laser-induced damage in IR optical crystals	5	77	295
Measurement of picosecond absorption recovery time for dye molecules	5	77	299
Test of laser output performances of Nd:YAG crystals by low energy pumping	5	77	302
Statistical properties of intensity of partially polarized laser speckle pattern	5	77	<b>3</b> 06
Experimental analysis of accuracy for a calibrated equipment with capacitor			
discharge	5	77	309
China emphysizes laser applications	5	77	311
Amplified spontaneous emission and discrimination of radiative spectral			
characteristics	5	77	315
Laser spectroscopy for supersonic molecular beams	6	<b>7</b> 8	321
Verification of metric theory of gravitation using beam width correction for		.,-	
Sagnac effect	6	78	327
Causes for degradation of isolated stripe (GaAl) As/GaAs DH lasers by proton			
bombardment	6	78	<b>3</b> 31
Frequency correction for optical gyros	6	78	<b>3</b> 34
Second harmonic generation of TEA CO <sub>2</sub> 10.6 µm laser light in AgGaS <sub>2</sub> crystals	6	78	<b>3</b> 39
Investigation on correlation of CW CO laser lines	6	78	843
Laser Raman spectra of terpene compounds	6	78	347
Synthesis of Rhodamine 640 with rigid structure and its spectral and lasing			-
behaviour	6	78	351
Effect of infrared laser radiation on liquid-liquid extraction of uranyl from			
aqueous solution	6	<b>7</b> 8	354
Discharge characteristics of an excimer laser with Blumlein type UV preioni-			
zation energy coupling relationship	6	78	358
Parameters and aberrations of holographic screen projection system for static		•	*
three dimensional images	6	78	362
Influence of water on nonradiative relaxation of ${}^4F_{3/2}$ state in Nd <sup>3+</sup> -phosphate			
glasses	6	78	366
Simplified optical-path design and the characters of a multipass reflective cell	6	78	370

A laser pulse slicer with cryotron  An improved type of W. Rogowski electrodes  A free electron laser with variable spatial period length in weggler  Lamb's theory of traveling—wave Gaussian beams and output expressions of ring lasers considering the radial distribution  CO₂ laser power stabilization by feedback loop  7 79 389  Southers of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling  Infinerse of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling  Infinite resolution of holographic Fourier—transform spectroscopy  7 79 400  Stimulated Raman scattering in liquid air  A high power vortex gas flow stabilized flashlamp  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAb DH lasers"  7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera  Lans design for target experiments  A high accuracy thermostat with auto—drift—compensation  7 79 430  A high accuracy thermostat with auto—drift—compensation  7 79 400  Kinetics of electron beam—pumped excimers  10 80 685  Discussion on CW laser oscillation process via optical Eloch equations  A model of single longitudinal mode semiconductor laser by means of internal—reflection optical coupling  A LiF: F7 crystal Q—switched Nd glass laser  Horizontal unseeded vapor growth (HUVG) of a Pb₁—Sn₂Te diode laser  10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser  Magnetic induced beat noise in an intracavity He-Ne laser  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an acousto—optic deflector  10 82 710  Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magnetic induced planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate  laser glasses  10 82 726  Spectra and structure of HoP <sub>2</sub> O <sub>14</sub> crystals  Auto		No.	Cum. No.	Page
A free electron laser with variable spatial period length in weggler 7 79 385  Lamb's theory of traveling—wave Gaussian beams and output expressions of ring lasers considering the radial distribution 7 79 389  CO, laser power stabilization by feedback loop 7 79 395  Discharge characteristics of XeCl lasers 7 79 395  Influense of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling 7 79 403  Lifmite resolution of holographic Fourier—transform spectroscopy 7 79 407  Lifmite resolution of holographic Fourier—transform spectroscopy 7 79 407  Stimulated Raman scattering in liquid air 7 79 412  Maigh power vortex gas flow stabilized flashlamp 7 79 415  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424  Lones design for target experiments 7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424  A high accuracy thermostat with auto—drift—compensation 8 80~81 449  A high accuracy thermostat with auto—drift—compensation 7 79 430  Special issue of '83 ICL 8 8~9 80~81 449  Kinetics of electron beam—pumped excimers 10 80 685  Discussion on CW laser oscillation process via optical Bloch equations 10 82 692  A model of single longitudinal mode semiconductor laser by means of internal—reflection optical coupling 10 82 696  A Liff:Fi crystal Q—switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a PhSn_Te diode laser 10 82 704  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 704  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 704  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 715  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 715  Magnetic induced beat noise in an intracavity He—Ne laser 10 82 715  Magneto-optic m	A laser pulse slicer with cryotron			374
A free electron laser with variable spatial period length in weggler 7 79 385  Lamb's theory of traveling—wave Gaussian beams and output expressions of ring lasers considering the radial distribution 7 79 389  Col, laser power stabilization by feedback loop 7 79 395  Discharge characteristics of XeCl lasers 7 79 395  Influense of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling 7 79 403  Infinite resolution of holographic Fourier—transform spectroscopy 7 79 403  Stimulated Raman scattering in liquid air 7 79 412  A high power vortex gas flow stabilized flashlamp 7 79 415  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424  Lens design for target experiments 7 79 420  A high accuracy thermostat with auto—drift—compensation 8 80~81 449  Special issue of '83 ICL 8 8 9 80~81 449  Expectal sisue of '83 ICL 8 8 9 80~81 449  Discussion on CW laser oscillation process via optical Bloch equations 10 82 692  A Liff-Fr, crystal Q—switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Ph_Dar_Sa_Te diode laser 10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 715  Modulation transfer characteristics of an acousto-optic deflector 10 82 715  Magneto-optic materials of garnet single-mode pilother and single-mode p	An improved type of W. Rogowski electrodes	6	78	377
CO2   laser power stabilization by feedback loop   7   79   395	A free electron laser with variable spatial period length in weggler	7	79	385
CO <sub>2</sub> laser power stabilization by feedback loop  Discharge characteristics of XeCl lasers  Influense of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling  Influite resolution of holographic Fourier-transform spectroscopy  7 79 403  Influite resolution of holographic Fourier-transform spectroscopy  7 79 412  A high power vortex gas flow stabilized flashlamp  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers"  Ultrashort laser pulses for study of the picosecond image tube camera  7 79 422  Lens design for target experiments  A perture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering  A high accuracy thermostat with auto-drift-compensation  7 79 430  A high accuracy thermostat with auto-drift-compensation  7 79 430  A linetics of electron beam-pumped excimers  Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F <sub>7</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth(HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  Modulation transfer characteristics of an accusto-optic deflector  10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an accusto-optic deflector  10 82 714  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an accusto-optic deflector  10 82 712  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an accusto-optic deflector  10 82 713  Magnetic induced beat noise in an intracavity He-Ne laser  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an accusto-optic deflector  10 82 726  Magnetic induced beat noise in an intracavity He-Ne laser  Magnetic induced beat nois	Lamb's theory of traveling-wave Gaussian beams and output expressions of			
Discharge characteristics of XeCl lasers  Influense of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling  Infinite resolution of holographic Fourier-transform spectroscopy  7 79 403  Infinite resolution of holographic Fourier-transform spectroscopy  7 79 415  Stimulated Raman scattering in liquid air  A high power vortex gas flow stabilized flashlamp  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers"  7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera  7 79 424  Lens design for target experiments  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering  A high acouracy thermostat with auto-drift-compensation  7 79 430  A high acouracy thermostat with auto-drift-compensation  7 79 434  Special issue of '83 ICL  Kinetics of electron beam-pumped excimers  10 80 685  Discussion on CW laser oscillation process via optical Bloch equations  10 82 696  A McFiFi crystal C-switched Nd glass laser  10 82 702  Horizontal unseeded vapor growth (HUVG) of a PbiSn_Te diode laser  10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an acousto-optic deflector  Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Spectra and structure of HoP <sub>0</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation and experimental observation of laser hardening of carbon steels  Study on structure and property of laser hardening of carbon steels  11 83 754  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	ring lasers considering the radial distribution	7	79	<b>3</b> 89
Influense of longitudinal optical inhomogeneity of a nonlinear crystal on frequency doubling  Infinite resolution of holographic Fourier-transform spectroscopy  7 79 403  Stimulated Raman scattering in liquid air  A high power vortex gas flow stabilized flashlamp  7 79 415  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers"  7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera  7 79 421  Lens design for target experiments  7 79 422  Lens design for target experiments  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering  7 79 430  A high accuracy thermostat with auto-drift-compensation  7 79 430  Special issue of '83 ICL  Kinetics of electron beam-pumped excimers  Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:Fr crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 714  Magnetic materials of garnet single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Spectra and structure of HOP <sub>2</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 736  Spectra and structure of HOP <sub>2</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  11 83 754  Theoretical calculation and experimental observation of laser hardening of carbon steels  Study on structure and property of laser hardening of carbon steels  11 83 754  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	CO <sub>2</sub> laser power stabilization by feedback loop	7	79	395
Infinite resolution of holographic Fourier-transform spectroscopy 7 79 407  Stimulated Raman scattering in liquid air 7 79 412  A high power vortex gas flow stabilized flashlamp 77 79 415  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 77 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 77 79 424  Lens design for target experiments 77 79 420  Lens design for target experiments 77 79 420  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 77 79 430  A high accuracy thermostat with auto-drift-compensation 77 79 430  Special issue of '83 ICL 8~9 80~81 449  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 692  A LiF:Fr crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 704  Magnetic induced beat noise in an intracevity He-Ne laser 10 82 711  Optimization design of Faraday rotators 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Spectra and structure of HoF <sub>2</sub> O <sub>14</sub> crystals 110 82 735  Calculation of multiphoton process of Cs atoms 11 83 754  Study on structure and property of laser hardening of carbon steels 11 83 754  A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally	Discharge characteristics of XeCl lasers	7	79	399
Infinite resolution of holographic Fourier-transform spectroscopy 7 79 407  Stimulated Raman scattering in liquid air 7 79 412  A high power vortex gas flow stabilized flashlamp 77 79 415  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 77 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 77 79 424  Lens design for target experiments 77 79 420  Lens design for target experiments 77 79 420  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 77 79 430  A high accuracy thermostat with auto-drift-compensation 77 79 430  Special issue of '83 ICL 8~9 80~81 449  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 692  A LiF:Fr crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 704  Magnetic induced beat noise in an intracevity He-Ne laser 10 82 711  Optimization design of Faraday rotators 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Spectra and structure of HoF <sub>2</sub> O <sub>14</sub> crystals 110 82 735  Calculation of multiphoton process of Cs atoms 11 83 754  Study on structure and property of laser hardening of carbon steels 11 83 754  A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally	Influense of longitudinal optical inhomogeneity of a nonlinear crystal on			
Infinite resolution of holographic Fourier-transform spectroscopy  Stimulated Raman scattering in liquid air  A high power vortex gas flow stabilized flashlamp  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers"  7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera  7 79 424  Lens design for target experiments  7 79 426  Lens design for target experiments  7 79 430  A high accuracy thermostat with auto-drift-compensation in Shanghai and its application to laser engineering  A high accuracy thermostat with auto-drift-compensation  7 79 434  Special issue of '83 ICL  Kinetics of electron beam-pumped excimers  Discussion on CW laser escillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth(HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  Horizontal unseeded vapor growth(HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 714  Magneto-optic materials of garnet single-mode optical fiber and single-mode  planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoP <sub>2</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  Study on structure and property of laser hardening of carbon steels  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally		7	79	403
Stimulated Raman scattering in liquid air A high power vortex gas flow stabilized flashlamp Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 7 79 420 Ultrashort laser pulses for study of the picosecond image tube camera 7 79 421 Lens design for target experiments 7 79 422 Lens design for target experiments 7 79 423 Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 7 79 430 A high accuracy thermostat with auto-drift-compensation 8 8-9 80~81 449 Special issue of '83 ICL 8 8-9 80~81 449 Kinetics of electron beam-pumped excimers 10 80 685 Discussion on CW laser oscillation process via optical Bloch equations A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 692 A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 704 Magnetic induced beat noise in an intracavity He-Ne laser Modulation transfer characteristics of an acousto-optic deflector 10 82 714 Cptimization design of Faraday rotators Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 726 Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 736 Automatic monitoring of pulsed laser energy 10 82 736 Calculation of multiphoton process of Cs atoms 11 83 759 Kludy on structure and property of laser hardening of carbon steels 11 83 759 A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally	Infinite resolution of holographic Fourier-transform spectroscopy	7		407
A high power vortex gas flow stabilized flashlamp  Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers"  7 79 420  Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424  Lens design for target experiments  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering A high accuracy thermostat with auto-drift-compensation 7 79 430  Special issue of '83 ICL 8 9 80 811 449  Kinetics of electron beam-pumped excimers 10 80 685  Discussion on CW laser oscillation process via optical Bloch equations 10 82 692  A LiF:F7 crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb1_s_Sn_Te diode laser 10 82 707  Magnetic induced beat noise in an intracavity He-Ne laser Modulation transfer characteristics of an acousto-optic deflector 10 82 711  Optimization design of Faraday rotators Research on end coupling between single-mode optical fiber and single-mode planar waveguide Magneto-optic materials of garnet single crystal films for ring laser gyroscopes Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 726  Spectra and structure of HoP <sub>2</sub> O <sub>14</sub> crystals Automatic monitoring of pulsed laser energy 10 82 735  Calculation of multiphoton process of Cs atoms 11 83 754  Study on structure and property of laser hardening of carbon steels 11 83 759  A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally	<del>-</del>	7		412
Further discussion on "Infrared transmission/emission method for GaAlAs/ GaAs DH lasers" 7 79 420 Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424 Lens design for target experiments 7 79 427 Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 7 79 430 A high accuracy thermostat with auto-drift-compensation 7 79 434 Special issue of '83 ICL 8~9 80~81 449 Special issue of Signer oscillation process via optical Bloch equations 10 82 692 A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 702 A LiF:F; crystal Q-switched Nd glass laser 10 82 702 Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 704 Magnetic induced beat noise in an intracavity He-Ne laser 10 82 704 Magnetic induced beat noise in an intracavity He-Ne laser 10 82 711 Optimization design of Faraday rotators 10 82 714 Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 726 Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 726 Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals 10 82 735 Calculation of multiphoton process of Cs atoms 11 83 749 Theoretical calculation and experimental observation of laser hardening of carbon steels 11 83 754 Study on structure and property of laser hardening of carbon is thermally	A high power vortex gas flow stabilized flashlamp	7		
GaAs DH lasers"  7 79 420 Ultrashort laser pulses for study of the picosecond image tube camera 7 79 424 Lens design for target experiments 7 79 427 Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 7 79 430 A high accuracy thermostat with auto-drift-compensation 7 79 434 Special issue of '83 ICL 8-9 80~81 449 Kinetics of electron beam-pumped excimers 10 80 685 Discussion on CW laser oscillation process via optical Bloch equations A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1</sub> Sn <sub>2</sub> Te diode laser 10 82 702 Magnetic induced beat noise in an intracavity He-Ne laser 10 82 701 Modulation transfer characteristics of an acousto-optic deflector 10 82 711 Optimization design of Faraday rotators Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 719 Magneto-optic materials of garnet single crystal films for ring laser gyroscopes Study of the cause for light scattering and laser damage in fluorophosphate laser glasses Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals Automatic monitoring of pulsed laser energy 10 82 736 Calculation of multiphoton process of Cs atoms Theoretical calculation and experimental observation of laser hardening of carbon steels Study on structure and property of laser hardening of carbon steels 11 83 759 A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally	Further discussion on "Infrared transmission/emission method for GaAlAs/			
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Lens design for target experiments  Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering  A high accuracy thermostat with auto-drift-compensation  7 79 430  Special issue of '83 ICL  Kinetics of electron beam-pumped excimers  Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth(HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  10 82 702  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 701  Modulation transfer characteristics of an acousto-optic deflector  10 82 711  Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode  planar waveguide  10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Spectra and structure of HoP <sub>0</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally	Ultrashort laser pulses for study of the picosecond image tube camera	7		424
Aperture smoothing factor on atmospheric scintillation in Shanghai and its application to laser engineering 7 79 430  A high accuracy thermostat with auto-drift-compensation 7 79 434  Special issue of '83 ICL 8~9 80~81 449  Kinetics of electron beam-pumped excimers 10 80 685  Discussion on CW laser oscillation process via optical Bloch equations 10 82 692  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 696  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1</sub> Sn <sub>-</sub> Te diode laser 10 82 707  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 707  Modulation transfer characteristics of an acousto-optic deflector 10 82 711  Optimization design of Faraday rotators 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 713  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 730  Automatic monitoring of pulsed laser energy 10 82 735  Calculation of multiphoton process of Cs atoms 11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels 11 83 754  Study on structure and property of laser hardening of carbon steels 11 83 759  A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally		7	79	427
A high accuracy thermostat with auto-drift-compensation 7 79 434  Special issue of '83 ICL 8~9 80~81 449  Kinetics of electron beam-pumped excimers 10 80 685  Discussion on CW laser oscillation process via optical Bloch equations 10 82 692  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling 10 82 702  A LiF; F <sub>1</sub> crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 707  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 707  Modulation transfer characteristics of an acousto-optic deflector 10 82 711  Optimization design of Faraday rotators 10 82 712  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 736  Calculation of multiphoton process of Cs atoms 10 82 735  Calculation of multiphoton process of Cs atoms 11 83 754  Theoretical calculation and experimental observation of laser hardening of carbon steels 11 83 754  A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally	Aperture smoothing factor on atmospheric scintillation in Shanghai and its appli-			
Special issue of '83 ICL  Kinetics of electron beam-pumped excimers  Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  Horizontal unseeded beat noise in an intracavity He-Ne laser  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an acousto-optic deflector  Io 82 711  Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  Poetra and structure of HoP <sub>0</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  10 82 759  A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally	cation to laser engineering	7	79	430
Kinetics of electron beam-pumped excimers  Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser  Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an acousto-optic deflector  Discussion of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode  planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate  laser glasses  Discussion of East and Structure of HoP <sub>0</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	A high accuracy thermostat with auto-drift-compensation	7	79	434
Discussion on CW laser oscillation process via optical Bloch equations  A model of single longitudinal mode semiconductor laser by means of internal—reflection optical coupling  A LiF:F <sub>1</sub> crystal Q-switched Nd glass laser  10 82 702  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-s</sub> Sn <sub>s</sub> Te diode laser  10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 707  Modulation transfer characteristics of an acousto-optic deflector  10 82 711  Optimization design of Faraday rotators  10 82 714  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd; YAG laser and analysis on its thermally	Special issue of '83 ICL	8~9	80~81	449
A model of single longitudinal mode semiconductor laser by means of internal-reflection optical coupling  A LiF:F2 crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth(HUVG) of a Pb1-gSn2Te diode laser  10 82 702  Horizontal unseeded vapor growth(HUVG) of a Pb1-gSn2Te diode laser  10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 707  Modulation transfer characteristics of an acousto-optic deflector  10 82 711  Optimization design of Faraday rotators  10 82 714  Research on end coupling between single-mode optical fiber and single-mode  planar waveguide  10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate  laser glasses  10 82 726  Spectra and structure of HoP5014 crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Kinetics of electron beam-pumped excimers	10	80	685
A model of single longitudinal mode semiconductor laser by means of internal—reflection optical coupling 10 82 696  A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser 10 82 702  Horizontal unseeded vapor growth(HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser 10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 707  Modulation transfer characteristics of an acousto-optic deflector 10 82 711  Optimization design of Faraday rotators 10 82 714  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 736  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals 10 82 735  Calculation of multiphoton process of Cs atoms 11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels 11 83 754  Study on structure and property of laser hardening of carbon steels 11 83 759  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Discussion on CW laser oscillation process via optical Bloch equations	10	82	692
A LiF:F <sub>7</sub> crystal Q-switched Nd glass laser  Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-s</sub> Sn <sub>s</sub> Te diode laser  10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser  10 82 707  Modulation transfer characteristics of an acousto-optic deflector  10 82 711  Optimization design of Faraday rotators  10 82 714  Research on end coupling between single-mode optical fiber and single-mode  planar waveguide  10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate  laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	A model of single longitudinal mode semiconductor laser by means of			
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Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-s</sub> Sn <sub>s</sub> Te diode laser 10 82 704  Magnetic induced beat noise in an intracavity He-Ne laser 10 82 707  Modulation transfer characteristics of an acousto-optic deflector 10 82 711  Optimization design of Faraday rotators 10 82 714  Research on end coupling between single-mode optical fiber and single-mode planar waveguide 10 82 719  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes 10 82 723  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses 10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals 10 82 730  Automatic monitoring of pulsed laser energy 10 82 735  Calculation of multiphoton process of Cs atoms 11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels 11 83 759  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	A LiF:F <sub>2</sub> crystal Q-switched Nd glass laser	10	82	702
Magnetic induced beat noise in an intracavity He-Ne laser  Modulation transfer characteristics of an acousto-optic deflector  10 82 711 Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  10 82 719 Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726 Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735 Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754 Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Horizontal unseeded vapor growth (HUVG) of a Pb <sub>1-x</sub> Sn <sub>x</sub> Te diode laser	10	82	704
Optimization design of Faraday rotators  Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Magnetic induced beat noise in an intracavity He-Ne laser	10	82	707
Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoPoO14 crystals  Automatic monitoring of pulsed laser energy  10 82 736  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Modulation transfer characteristics of an acousto-optic deflector	10	82	711
Research on end coupling between single-mode optical fiber and single-mode planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  11 83 759  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Optimization design of Faraday rotators	10	82	714
planar waveguide  Magneto-optic materials of garnet single crystal films for ring laser gyroscopes  Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Research on end coupling between single-mode optical fiber and single-mode			-
Study of the cause for light scattering and laser damage in fluorophosphate laser glasses  10 82 726 Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  10 82 730 Automatic monitoring of pulsed laser energy  10 82 735 Calculation of multiphoton process of Cs atoms  11 83 749 Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754 Study on structure and property of laser hardening of carbon steels  11 83 759 A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	planar waveguide	10	82	719
laser glasses  10 82 726  Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Magneto-optic materials of garnet single crystal films for ring laser gyroscopes	10	82	723
Spectra and structure of HoP <sub>6</sub> O <sub>14</sub> crystals  Automatic monitoring of pulsed laser energy  10 82 735  Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Study of the cause for light scattering and laser damage in fluorophosphate			
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Calculation of multiphoton process of Cs atoms  11 83 749  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Spectra and structure of HoP <sub>5</sub> O <sub>14</sub> crystals	10	82	730
Calculation of multiphoton process of Cs atoms  Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 749  Carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Automatic monitoring of pulsed laser energy	10		
Theoretical calculation and experimental observation of laser hardening of carbon steels  11 83 754  Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Calculation of multiphoton process of Cs atoms		83	
carbon steels 11 83 754 Study on structure and property of laser hardening of carbon steels 11 83 759 A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Theoretical calculation and experimental observation of laser hardening of			
Study on structure and property of laser hardening of carbon steels  A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally	taran da antara da a	11	83	754
A high repetition rate mode-locked Nd:YAG laser and analysis on its thermally	Study on structure and property of laser hardening of carbon steels			759
stable resonator 11 83 765	A high repetition rate mode-locked Nd: YAG laser and analysis on its thermally			
	stable resonator	11	83	765

	No.	Cum.No.	Page
Research of stability of Nd:YAG AM mode-locked laser	11	83	770
Discharge spectra of mercuric halides and their kinetic processes	11	83	774
Preparation of doped-KCl single crystals as color center laser material	11	83	778
Study of non-crystalline metals by laser irradiation using SEM	11	83	782
Measurement of photoacoustic signal by laser heterodyne at high temperature	11	83	785
Frequency doubling of a CW dye laser with an external auxiliary active cavity	11	83	788
Measurement of atmospheric attenuation of DF/HF chemical laser radiation	11	83	792
Laser welding of titanium	11	83	795
Application of liquid crystal light valve to real-time optical data processing	11	83	798
A pulsed HF laser with unstable resonator	11	83	801
Continuously tunable helium replennisher for long lifetime He-Cd laser	11	83	804
Possibility of developing a new kind of optical elements	11	83	807
Full quantization theory of resonant mutiphoton transition	12	84	813
Analytic resolution for small signal gain along the direction of gas flow of			
a transverse flow CO <sub>2</sub> laser	12	84	821
Effects of rare-earth elements on KNdP <sub>5</sub> O <sub>12</sub> laser crystals	12	84	826
Stabilization of CO <sub>2</sub> laser frequency with NH <sub>2</sub> D Stark cell	12	84	829
Thermal distortion of Nd-glasses	12	84	832
Study on improvement of lifetime for UV-TEA CO <sub>2</sub> laser by catalytic			
reaction of decomposed products	12	84	837
Talbot effect in an infrared laser field and its applications	12	84	840
A remote controlled pulsed laser Doppler velocimeter	12	84	843
Automatic laser alignment system for workpiece setting	12	84	845
A simple and practical set-up for measuring the duration of single ultrashort			
pulses	12	84	848
Laser thin film for frequency doubling—high transmissivity at 1.06 $\mu m$ and			
high reflectivity at 0.53 $\mu \mathrm{m}$	12	84	853
DISCUSSION		•	
Experimental study on lowering the breakdown voltage for laser tubes	1	73	53
On the mechanisms of breakdown voltage of gas laser tubes	1	73	<b>5</b> 6
SCIENCE NOTES			
Misalignment sensitivity of cube corner reflector-concave mirror resonators	1	73	<b>5</b> 8
Frequency shift of SRS in benzene and phase matching	1	73	<b>6</b> 0
Discharge delay of cross-excitation in laser microspectroscopy	1	73	61
Generation of short pulses in Nd:YAG lasers	1	73	62
Compression of Raman laser pulses by travelling wave pumping	2	74	120
Wide range frequency conversion by SRS in compressed hydrogen	2	74	<b>12</b> 0
Distributed feedback dye lasers	2	74	121
A laser detector using plasma	2	74	123
Anesthesia in YAG laser operation	2	74	124

	No.	Cum.No.	Page
Skin cancer treated with refrigeration and CO <sub>2</sub> lasers	2	74	126
Observation of curative effect in the treatment of caruncle urethra with laser	2	74	127
Clinical observation of 160 cases of cervix erotion treated with CO <sub>2</sub> lasers	2	74	128
PT-1 laser calorimeter for measuring weak laser energy	3	75	186
Revised method of dialing code for laser interferometric length measurement	v	10	. 100
system	3	75	188
Experimental research of biological effects on a human liver carcinoma cell	Ü	10	100
line (BEL-7402) in vitro with an argon laser	4	76	249
A small CW HF chemical laser	. 4	76	250
Real-time measurement of two dimentional far field pattern for semiconductor			.200
lasers	4	76	251
Observation of 48 cases of clinical results on sequels of cerebral concussion with	7	10	401
low power He-Ne laser acupoint radiation	4	76	050
Analysis on the cathode of a He-Ne laser with scanning electron microscope	4 5	76 77	253
Animal test of CO <sub>2</sub> laser induced wound cured with He-Cd laser irradiation	_		317
Using pentamethlidyne dye as film sensitizer at 1.06 $\mu$ m	5	77	320
Laser ranging experiment for Lageos	6 6	78 78	381
Observation on therapeutic efficacy of late lung cancer by a N <sub>2</sub> laser and	U	10	382
other means		70	004
Design parameters and improvement of model WJX-I laser microspectrometer	6 7	78 79	384
A short note on laser annealing	7		437
A new medium for real-time laser display and recording	7	79 79	438
A preliminary report on study of controlling blister rust of Korean pine by	•	19	439
laser	7	79	4 4 4
Effects of low power He-Ne laser radiation on red blood cell membrane of rats	7	79 79	441
Measurement and analysis of the TPF patterns of ultrashort pulse using closed	•	18	443
circuit TV with memory system	10	82	77.40
Study on x-ray preionization performances	10	82	740
Measurement of gain coefficient of a transverse flowing CO <sub>2</sub> laser	10	82	741
Model LG-1000 high power meter for lasers with flowing water compensation	10	82	743
Optical characteristics of GaP prism couplers	11	83	745
Properties of Nd-glass laser at 1.36 µm	11		810
A miniature solid state laser	12	83 84	811
Chemical vapor deposition of silicon films by preheating the substrates with	12	84	857
laser	10	0.4	050
Investigation on combining therapy of 6 cases of liver hetephase and advanced	12	<b>84</b>	<b>85</b> 8
stage carcinoma with CO <sub>2</sub> laser	10	04	050
The therapeutic effect of acite diffuse otitis externa and furnuculosis of the	12	84	859
external auditory with low power He-Ne laser irradiation	10	04	000
. F Land 110 most middlenion	12	84	860

	No.	Cum.No.	Page
AUTHORS AND READERS			
Exploration on "reconstructed multi-image" of holograms	7	<b>7</b> 9	445
Can a hologram reconstruct multi-images of the first order?	12	84	861
LETTERS			
Evaluation meeting on laser drilling of oil nozzle held in Changchun, Jilin			
Province	1	73	57
An optically-pumped FIR laser with stable output power	1	73	64
A 600W immersed CO <sub>2</sub> laser with V-shaped folded cavity	1	73	64
Detection and catalytic purification of working gas for JL6A lasers	3	75	191
A high-performance KD*P index-matching liquid	3	75	191
Demonstration on quasi-phase conjugation properties of glass bead arrays	3	75	191
The Second Symposium on Laser in Medicine of Jiangsu Province held in Taizhou	3	75	192
A laser at OIII 559.2nm with air as active gas	4	76	253
A high repetition rate mode-locked phosphate glass laser	4	76	254
A box-calorimeter for measurement of scattered laser energy	4	76	255
156 cases of abnormal fetal position treated with laser needle	4	76	255
One case of localized hyperhydrosis treated by He-Ne lasers	4	76	256
Symposium on Laser in Medicine of Beijing and Anhui districts held in			
Huangshan Mountain	4	76	<b>2</b> 56
DW-I laser gauge for measurement of outer diameter of cables	5	77	301
Efficient output of LiF:F <sub>2</sub> centers	7	79	447
Tunable pulse laser output in crystal LiF:F2	7	79	447
National laser heat treatment technical interchange meeting and discussion	·		
held in Wuhan	7	79	448
The 2nd plenary session and symposium of the Laser and Infrared Society of	•		220
Xian held	7	79	448
New filtering materials for lasers	<b>1</b> 0	82	739
Intrinsic optical bistability of BDN dye solution	10	82	747
Pieces of information on clinical applications of He-Ne laser	10	82	747
Multiorder stimulated Raman scattering in near infrared region from the	10	02	141
monomode optical fibre	10	82	748
Magnetically polarized 6328Å He-Ne laser developed	10	82	748
National symposium on stimulated light scattering held in Leshan	11	83	812
Meeting on optical fiber sensors and their application held in Yandzhou	12	84	856
The Second National Symposium on Integrategrated Optics held in Changchun	12	84	863
Symposium on reconstruction of multi-images from a holographic plate held in	10	UI	000
	12	84	864
Qingdao	12	84	864
Laser irradiation of wen			
Annual Cumulative Contents of Volume 10, Chinese Journal of Lasers (1983)	12	84	865

#### Armaments

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A TO SHE PARK

TITLE: "Application of Complex Control in the Control System of Antitank Guided Missiles"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 4, Nov 83 pp 28-35

TEXT OF ENGLISH ABSTRACT: Based upon the invariance principle [symmetry law], this paper analyzes the possibility of applying complex control in the control system of antitank guided missiles. The structure and the parameters of a compensation network of a practicable complex control system are obtained. Calculation results of a simulated system are also given.

This paper was received for publication on 11 December 1981.

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TITLE: "Analysis of Signals of Reflected Laser Waveshape"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 4, Nov 83 pp 9-20

TEXT OF ENGLISH ABSTRACT: Based upon the concept of equivalent section of reflection of laser targets, this paper proposes a general equation for calculating the laser waveshape reflected from a target. Analytical representations of laser waveshapes reflected from planar, spherical, and cylindrical targets are thus derived. The results of calculation are obtained with the aid of a computer which also produces the waveshape and the frequency spectrum. A theoretical basis and a computer reference are, therefore, supplied for the correct determination of the bandwidth of the receiver. In theory, a method of selecting the pulse width of laser emission is also proposed for the purpose of maximum utilization of the emitted energy if an axial length in the illuminated direction is present in the target.

This paper was received for publication on 19 June 1982

4

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TITLE: "A Study on the Effects of a Polyurethane Wear-reducing Additive in Propellant Grain"

SOURCE: Beijing BINGGONG XUEBAO [ACTA ARMAMENTARII] in Chinese No 4, Nov 83 pp 45-49

ABSTRACT: This paper introduces a polyurethane wear-retarding additive suitable for small arms. The additive is added internally to the propellant grain, instead of the firing barrel, to cause the characteristic of the propellant to be modified. Effects of the additive in prolonging the useful life of the gunbarrel are studied. Worn-out barrels are dissected to analyze the differences in burn, erosion, etc. brought about by the additive. Further studies on the possibility of extending the wear-reducing mechanism of the additive to explosives of other forms of guns are awaited in the future.

This paper was received for publication on 25 December 1981.

6248

cso: 4009/31

# CDMA Systems

AUTHOR: RAO Shilin [7437 0013 7792]

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TITLE: The Application of Cyclic Codes in CDMA Systems

SOURCE: Beijing TONGXIN XUEBAO [JOURNAL OF CHINA INSTITUTE OF COMMUNICATIONS] in Chinese No 4, 1983 pp 97-100

ABSTRACT: In this paper the following ideas are explained:

- (1) Some cyclic codes, having good autocorrelative and crosscorrelative coefficients, are suitable to be used as code-sequences in CDMA systems. This paper analyzes the properties of these cyclic codes, and gives mathematical proofs for the same.
- (2) A  $(2^{\lambda} 1, 2\lambda)$  cyclic code defined in this paper has equivalent correlative property and same address number with a Gold optimum seeking sets.
- (3) Cyclic codes are more flexible than Gold optimum seeking sets. A  $(2^{\lambda} 1, 2\lambda + 1)$  cyclic code can get twice address number as a Gold optimum seeking sets; although a  $(2^{\lambda} 1, \lambda + 1)$  cyclic code can get only two addresses, yet it has very good autocorrelative and crosscorrelative coefficients; and still more, cyclic codes can be used without subjecting to the limit of code length  $n = 2^{\lambda} 1$ .

## Character Recognition

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TITLE: "An Inclusive Matching Method of Chinese Character Recognition and Its Application"

SOURCE: Beijing TONGXIN XUEBAO [JOURNAL OF CHINA INSTITUTE OF COMMUNICATIONS] in Chinese No 4, 1983 pp 52-54

ABSTRACT: This paper presents a new method of Chinese character recognition—"Inclusive Matching Method." The paper first introduces the principle of the method and then the experiments undertaken to prove the effectiveness of the method. In the experiments, 5,659 out of 6,000 commonly used characters are classified into 198 groups in accordance with character components and radicals. If only characters classified into one group are considered to be in correct classification, the correct classifying rate is 97.29 percent, but if the 121 characters which enter either of the two groups are also counted in the correct classification, the correct classifying rate becomes 99.43 percent.

### Chemistry

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TITLE: "The Evaluation of Liquid Mixing Effects on Sieve Plate Efficiency Using Fiber Optic Technique"

SOURCE: Beijing HUAGONG XUEBAO [JOURNAL OF CHEMICAL INDUSTRY AND ENGINEERING (CHINA)] in Chinese No 3, Sep 83 pp 264-274

ABSTRACT: Longitudinal eddy diffusivities of liquid on sieve plates have been determined experimentally with fiber optic technique. The experiments were carried out in a rectangular simulator with air-water system. Two sieve plates were used: one with 5mm diameter holes and 7 percent free area of tray, the other 10 mm and 9 percent. The weir heights were ranged from 10 to 50 mm, as conventionally used nowadays.

The stimulus-response technique used was first proposed by Aris and later corrected by Bischoff. In the experimental work the tracer, here aqueous rhodamine-B solution being used, was not injected upstream inside the boundary of the active plate area, but upstream outside the boundary of that, i.e. injected into the liquid in the upstream downcomer, and the tracer concentrations were measured at two sections along the flow path. Consequently, the problem of a perfect delta function of tracer into the flowing system and the difficulty of uniformly distributing tracer along the section of injection were thus avoided.

Since the measuring probes were quite small in size (about 2 mm in diameter) and the tracer was not injected into the liquid on the plate, the flow pattern on plate would not be disturbed and the results should be more reliable than those reported previously in the literature.

The data have been correlated as follows:

(1) For Sieve plate with 5 mm holes

$$D_e^{0.5} = 0.0339 - 6.27 \times 10^{-4} h_w + 0.0165 F_T + 2.57 \times 10^{-3} L$$

(2) For Sieve plate with 10 mm holes

$$D_e^{0.5} = 0.0243 - 6.40 \times 10^{-4} h_W + 0.0121 F_T + 3.77 \times 10^{-3} L$$

And a generalized correlation for hole diameters from 5 to 10 mm is:

 $D_e^{0.5} = 0.0155 - 6.31 \times 10^{-4} h_w + 0.0275 F_T + 3.13 \times 10^{-3} L$ 

where

 $D_e = Eddy diffusivity, m^2/s$ 

 $F_T$  = Vapor flow parameter based on total column sectional area,  $(m/s) (kg/m^3)^{1/2}$ 

 $\boldsymbol{h}_{\boldsymbol{W}}$  = Height of weir above plate floor,  $\boldsymbol{m}\boldsymbol{m}$  .

L = Liquid flow rate,  $m^3/hr$  per m length of weir.

By using the eddy diffusion model and the eddy diffusivity found by the above correlations, the predicted Murphree efficiency agrees well with the actually determined one of a well-known precise experiment of Foss et al.

#### Contraceptives Studies

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TITLE: "Studies on Long Acting Contraceptives: Synthesis of 17  $\beta$ -steroid Esters"

SOURCE: Beijing YAOXUE XUEBAO [ACTA PHARMACEUTICA SINICA] in Chinese Vol 18 No 10, 29 Oct 83 pp 741-745

ABSTRACT: This paper reports the process of synthesizing five steroid esters of nonethisterone and the 17  $\beta$ -ester of norgestrel, in an experiment designed and carried out by the authors. The objective of the project, sponsored jointly by WHO, was to search for long acting contraceptives. Using dicyclohexylcarbodimide (DDC) as the dehydrating agent and 4-dimethylaminopyridine (DMAP) as the catalyst, the steroid and its corresponding acid were allowed to react directly to produce yields of 60-90 percent. Appropriate reaction conditions were observed and discussed. Physical and spectrographic data of the products, studied by thin layer chromatography, ultraviolet, infrared, and mass spectrometry, and nuclear magnetic resonance are included.

This paper was received for publication on 11 May 1982.

6248

### Nuclear Physics

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TITLE: "The Even-odd Effect of the Pre-equilibrium Emission in 59Co, 60Ni, 63Cu, 64Zn(a, p) Reactions"

SOURCE: Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese Vol 5 No 3, Aug 83 pp 193-202

TEXT OF ENGLISH ABSTRACT: Energy spectra of protons emitted in 63Cu  $(\alpha,p)$ , 64Zn $(\alpha,p)$ , and 60Ni  $(\alpha,p)$  reactions are measured at E = 18MeV. The results demonstrate that fractions of pre-equilibrium emission in odd-A target cases are greater than those in even-even target cases. These experimental findings are analyzed with the exciton model theory. The odd-even effect in the pre-equilibrium emission of 59Co, 60Ni, 63Cu, 64Zn  $(\alpha,p)$  reactions is further discussed. The authors believe that this is due to the fact that the fraction of pre-equilibrium emission depends heavily on the related binding and pairing energies while these energies have a systematic dependent relationship with the odd-even characteristic and the number of neutrons in the outer shell of the nucleus. The odd-even effect in the  $(\alpha,n)$  reactions and other related problems are also investigated; the conclusion is consistent with the above.

This paper was received for publication on 28 September 1982.

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TITLE: "Depth of Hydrogen in Thin Films With Elastic Recoil Detection Technique"

SOURCE: Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese Vol 5 No 3, Aug 83 pp 203-210

TEXT OF ENGLISH ABSTRACT: This paper introduces the elastic recoil detection technique for analyzing the hydrogen content in thin films and its depth profile. "He+ ions at energy of 2.1 MeV, furnished by a Van de Graaff accelerator, are incident on the target tilted at an angle of 75°. Energy analysis of H forward scatter yields a depth resolution of  $\leq$  500Å near the surface regions and a sensitivity of 0.1 percent for  $^1{\rm H}$  to depths of  $\leq$  0.5  $\mu{\rm m}$  in solids. This method has been used for depth profile of hydrogen in plasma deposited a-Si and

silicon nitride films combined with Rutherford backscattering and nuclear reaction  $^{16}\text{O}(d,p)$   $^{17}\text{O}$  techniques. The relations between hydrogen quantity in a-Si and the substrate temperature are given.

This paper was received for publication on 1 February 1983.

6248

### Petroleum, Uranium Geology

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TITLE: "Types of Granitic Magma and Their Ore-bearing Characteristics in the Northern Section of the Xikang-Yunnan Axis"

SOURCE: Beijing YANSHI KUANGWU JI CESHI [ACTA PETROLOGICA MINERALOGICA ET ANALYTICA] in Chinese Vol 2 No 3, Sep 83 pp 174-178

ABSTRACT: The Xikang-Yunnan axis is China's famous south-north tectonic belt on the western margin of the Yangzi platform. In its northern section, there is an extensive distribution of different kinds of granite to form a granitic zone of a south-north orientation between two deep fractures. The paper divides the granites into the two large categories of the crust refusion S type and the upper mantle basic magmatic differentiation I type. The former, located within the platform, is closely associated with rhyolite and produces chiefly tin and tungsten. The latter, found in the transitional trough, is associated with gabbro and syenite and related to deposits of rare-earth, niobium and tantalum. With maps and laboratory data, the temporal and spatial distribution, the petrochemical properties, the ore-bearing characteristics, and the petrogenetic mechanism of these granites are discussed.

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TITLE: "Determination of Uranium in Ores and Dressing and Metallurgical Samples by XRF Spectrometry"

SOURCE: Beijing YANSHI KUANGWU JI CESHI [ACTA PETROLOGICA MINERALOGICA ET ANALYTICA] in Chinese Vol 2 No 3, Sep 83 pp 213-214

ABSTRACT: For the purpose of finding a simple and effective method overcoming the basal body effect, uranium absorption behavior of resins was studied to conclude that the 742 anion resin absorbs and washes faster because of its large pores. Finally, a procedure is formulated to use the 742 anion resin for static absorption in a sulfuric acid medium to isolate uranium for x-ray measurement. Test measurements were performed with 0.138 percent samples for 15 times: the standard deviation was computed to be 0.0027, the fluctuation coefficient 1.98 percent. A VRA.2 X-ray fluorescence spectrograph made in East Germany was used for the experiment.

6248

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END